

# MODERN PLASTICS

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## *Next Month*

Winners in Modern Plastics Second Annual Competition will be pictured and described in our November number and throughout October and November all entries in the Competition will be exhibited in our Reception Auditorium, 425 Fourth Avenue, New York City, which has been completely redesigned and rebuilt for this event.

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# ORGANIC PLASTICS—VITAL INDUSTRIAL RAW MATERIALS

by T. W. DELAHANTY

THE GROWING IMPORTANCE OF ORGANIC plastics in the United States has been evidenced by a phenomenal growth in production and consumption, particularly in recent years. The industry now has a recognized place in our National economy, and the many applications of plastics and molded products in everyday life and their progress in world commerce as well as their utilization in practically every branch of industry, emphasizes the high degree to which they participate in modern existence. Illustrative of the extensive scope and range of uses of plastic products are the two outstanding groups—artificial or synthetic resins and plastics of cellulosic origin.

Synthetic resins are employed in the manufacture of molding powders which in turn take form in special designs for use as electrical components, radio parts, timing gears, bottle caps and even furniture. These resins find employment in the automobile, electrical and marine industries as well as in the manufacture of adhesives, printing inks, varnishes and lacquers and laminated sheets. Plastics of cellulose origin such as the nitrocellulose (pyroxylin) and the cellulose acetate products are well-known through their application in the manufacture of safety glass and through their utilization in the form of novelties—toys, fountain pens, toiletware, etc.

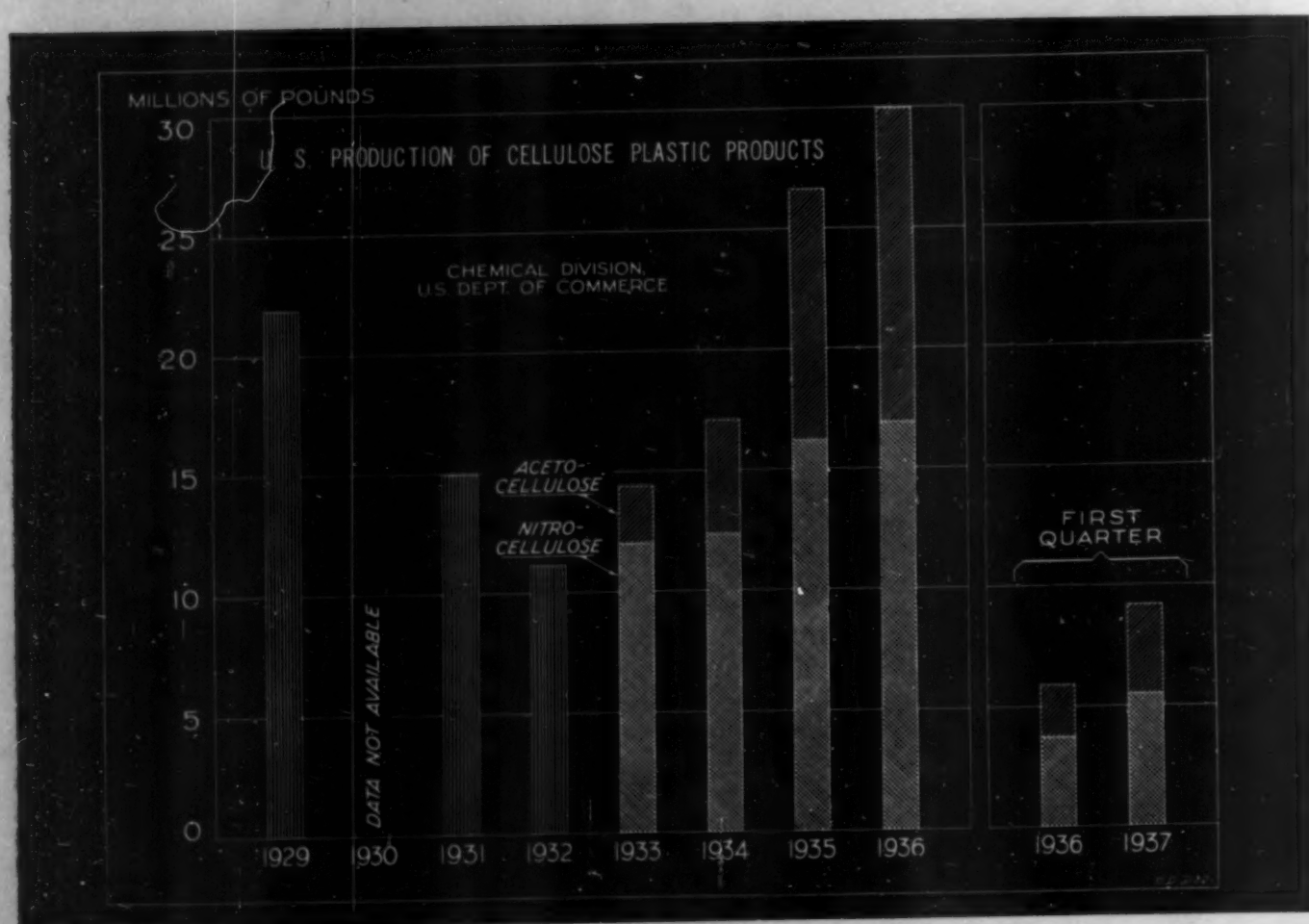
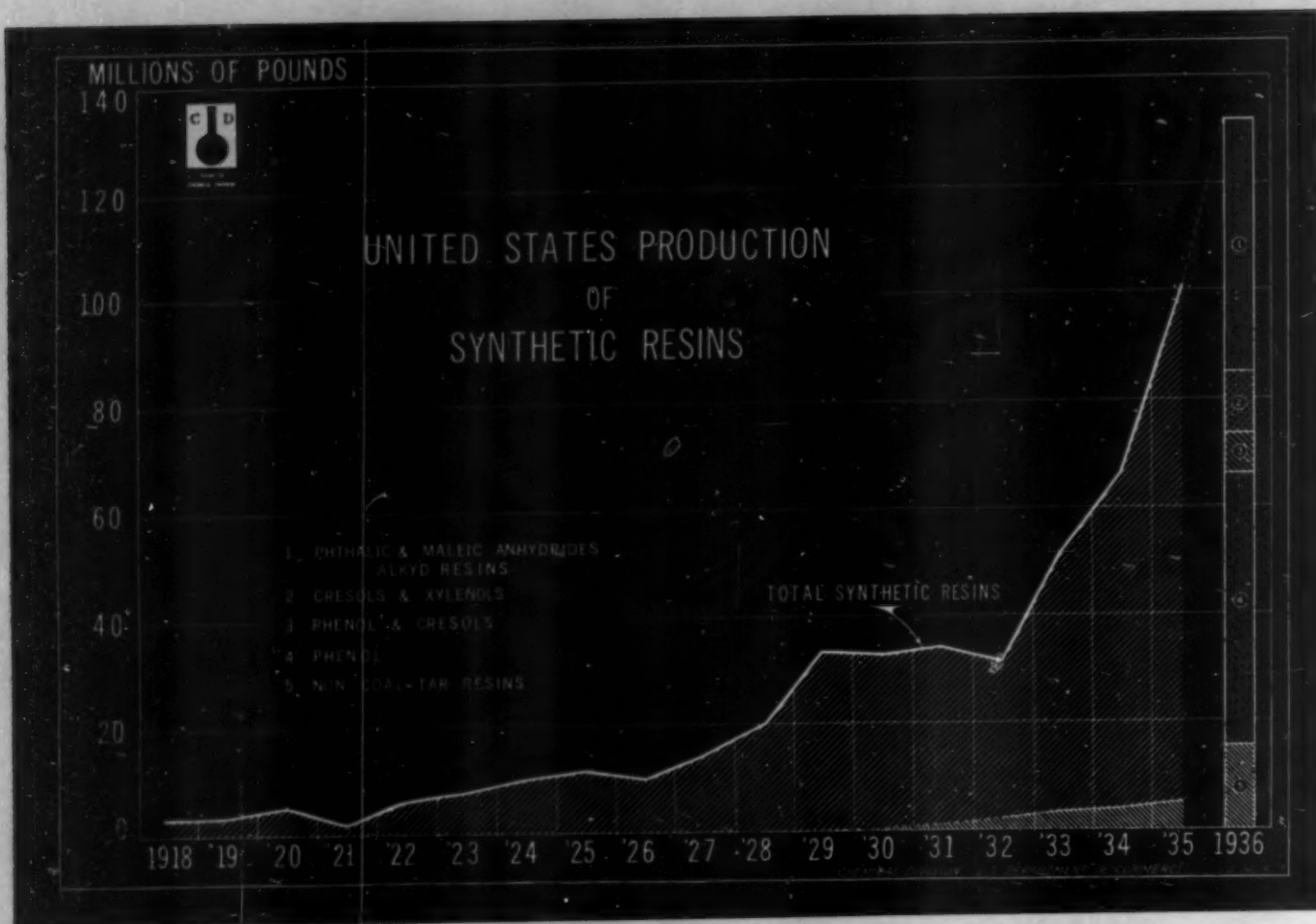
While plastics made from hardened casein have been in vogue for many years, it is only recently that the protein from soybeans has been employed on a commercial scale in the manufacture of plastic products. These are now being used in the production of automobile parts and for interior body work.

The plastics industry is in a state of flux and is constantly expanding its scope and increasing its magnitude.

According to a preliminary report compiled from data collected in the recent Biennial Census of Manufactures, the total production of plastics and plastic products in 1935 (the last Census year) by establishments in the chemical industry is valued at \$44,163,055, an increase of 82.6 percent as compared with \$24,188,191 reported for 1933. This does not include nitrocellulose articles made from purchased nitrocellulose plastics by establishments in a number of other industries. As a matter of fact, the domestic plastics industry is of so diversified a nature that adequate data showing production in all branches and distribution through all channels are not available. Indeed the industry is so decidedly not a static one that it is practically impossible to chronicle day to day progress. Trends of the day undoubtedly point to continued expansion in the plastics and molded products industries.

## Synthetic resins

Originally an American achievement, this country has contributed largely of its inventive talent and distributive genius to the synthetic resin field. Of the various types of synthetic resins some advanced commercially more rapidly than others. The phenolic type is a striking example. Although the phenol-formaldehyde condensation reaction had been known as a scientific fact for many years it was not until the reaction was investigated for commercial purposes that it became an industrial success and achieved commercial recognition. Other types were retarded in their progress because of inadequate commercialization. This is evident of the urea resins. The alkyd resins while initially entering the picture somewhat later have made remarkable progress during recent years, until in 1936 United States



production was reported at about 47 million pounds. Each year has witnessed a marked expansion in synthetic resin production and this is not surprising when it is considered that these products are adaptable for so many uses—from heavy construction material to exquisite and delicate jewelry. Total domestic synthetic resin output in 1936 amounted to 132 million pounds according to preliminary figures. Those of coal-tar origin (exclusive of resins derived from coumarone and indene, styrol, hydrocarbons and sulphonamides) totaled slightly over 116,300,000 pounds.

Contributing in no small degree to the success of the synthetic resins branch of the plastic industry is the availability of raw material of synthetic origin—phenol from benzol, formaldehyde through oxidation of methanol in turn manufactured from waste gases, the vapor-phase production of phthalic anhydride from naphthalene. These are but a few examples of the contribution to plastics of the synthetic organic chemical industry. In 1936, according to preliminary data, production of phenol aggregated 48,724,000 pounds and phthalic acid and anhydride 31,244,000 pounds, decided increases over the output of previous years. Increased domestic production of formaldehyde was registered in 1936.

#### Cellulose plastics

These find their origin in cellulose material such as cotton linters, or wood pulp after treatment with appropriate acids (nitric or acetic) and subsequently with solvents. The resultant viscous liquid or plastic mass may then be molded into sheets, rods, blocks or tubes. An important consuming channel for nitrocellulose is in protective coatings many of which are flexible and waterproof and may be applied in short order through sprayers. Another large outlet is imitation leather, generally a pyroxylin coated fabric.

Cellulose acetate plastics have assumed a high degree of commercial importance, production in 1936 being over 13,000,000 pounds a many-fold increase over previous years. Its employment in the manufacture of safety glass has greatly expanded and is widening in films.

Data shown in Fig. 2 refer only to raw material in the form of sheets, rods and tubes. The chart shown herewith, however, indicates the production trend over a larger period of years.

#### Foreign developments

In Germany, as in most countries, the pyroxylin (plastics) industry is the oldest branch of the plastics

industry. While still under 1929 levels, production of pyroxylin plastics has increased in recent years rising in 1935 to about 5000 metric tons. Next to the United States, it is believed that Germany is the world's largest producer of synthetic resins. In contrast to the older materials, synthetic resins have registered greater expansion, 1935 production having registered a peak of between 23,000 and 25,000 metric tons. About 90 percent of German synthetic resin production is of phenolic origin. Production figures for 1936 are lacking but it is believed that production exceeded that of the preceding year.

French production of plastic materials seems to have increased during recent years, more than a dozen manufacturers being engaged in the production of synthetic resins. Production of pyroxylin plastics is said to be around 3000 tons a year. Production figures covering the French synthetic resin industry are unavailable but trade estimates place 1934 production as around 1500 metric tons.

Plastics production in Great Britain is on the upward trend. The 1934 output of synthetic resins totaled 225,000 cwts. (1 cwt. equals 112 pounds) valued at £1,021,000 an increase over 1933 production of 156.5 cwts. (£699,000). Galalith and pyroxylin plastics also showed an increase.

Practically no pyroxylin plastics are being produced in Czechoslovakia at the present time. Synthetic resins have replaced this type of plastic as well as other materials in the manufacture of a number of products because of their neat and attractive appearance.

Japan is logically a significant producer of pyroxylin plastics when it is considered that it is the home of the camphor industry. This branch of the plastics industry has been aided by cheap labor. The pyroxylin branch is reported to have grown considerably in recent years and to compare favorably with the same industry in other producing countries.

There are a number of firms in Japan manufacturing synthetic resins these being principally of the phenolic type. Production of synthetic phenolic resins in 1934 amounted to 652,717 kilos in plants employing more than 5 operatives each, a considerable advance over the 104,479 kilos reported in 1933. Molded products are made not only by the large synthetic resins manufacturers but in a large number of small enterprises, the majority being household industries which secure their molding material from large concerns.

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# MATERIALS

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A MOLDER'S ORGANIC CHEMISTRY

ACRYLIC RESINS

ALKYD RESINS

CASEIN

CAST RESIN

CELLULOSE ACETATE

COUMARONE-INDENE

ETHYLCELLULOSE

FILLERS

FURFURAL

LIGNIN

METHYL METHACRYLATE

NITROCELLULOSE

PHENOLICS

PHENOLIC-ASBESTOS

RUBBER-LIKE RESINS

SHELLAC

TRANSPARENT PHENOLS

UREAS

VINYL AND POLYSTYRENE

# A MOLDER'S ORGANIC CHEMISTRY OF PLASTICS

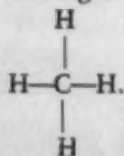
by GEORGE K. SCRIBNER

THE MODERN AND YOUTHFUL INDUSTRY OF plastics is based on organic chemistry so complicated that only an expert can follow its ramifications. As a matter of fact, although one expert alone may be an authority, two can be counted on for a debate and three or more for a battle royal, so intricate becomes the theory. Few of us studied organic chemistry in our younger days, and of those who did, so many studied it in a perfunctory way and without the vision of plastics before them that we are giving here a very brief outline of the science so that the words that crop up in our trade, such as methyl methacrylate and phenolics, will not seem so mysterious. Note that we say "seem so"; yours will probably be only a distant nodding acquaintance by the end of this article.

In the early days of chemistry two main classes were set up—Organic and Inorganic. The laboratory workers of the early 1800's could reproduce many of the mineral base compounds and could visualize the possibility of reproducing all of them in time. Nature, however, seemed to have a secret that defied them. There was a huge group of compounds obtained from vegetable matter that required some mysterious vital force to assist in its creation, something seemingly beyond the powers of the laboratory. Thus the simpler mineral base compounds were called Inorganic, and the mysterious vegetable compounds that needed life, growth, to come into being were called Organic.

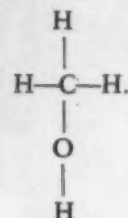
In 1828 the first natural product was duplicated, or synthesized, and from then on the tricks of the chemist have become increasingly complicated and far flung. Actually today organic chemistry covers the home life of carbon, oxygen and hydrogen, with occasional visits from outsiders such as nitrogen, sulphur, phosphorus and their like. The intricate combinations of these elements, with minor and many times unexplainable help from the inorganic elements become you and me, cats, trees, grass, food and, among other things, plastics.

In the first approach to the actual pre-natal behavior of our automobile door handles and radio cabinets, we must consider valency, or the atom-fixing power of our new acquaintances, nicknamed C, H and O. Hydrogen has one arm only, oxygen two. Water,  $H_2O$ , shows both hands of O extended with one hydrogen hanging on each, quite tenaciously in this case,  $H-O-H$ . Carbon has four arms. Methane or marsh gas is  $CH_4$ ;



hydrogen keeps all four arms busy. Some hand clasps are tighter than others; one or more hydrogen atoms can be shaken off and a new friend taken on.

$CH_3OH$  is methyl alcohol.



We still have

the same hand clasps because O has one hand extended in each direction, H on one side and one hand of the C on the other.

Unfortunately for the simplicity of this approach we find many compounds, called isomers, that have the same number of each element in the formula, but very distinctive qualities that differ widely among themselves. The chemist can prove that in this case the difference lies in the fact that one H is sitting on C's shoulder as opposed to one sitting on the ground at C's feet. This, however, is getting too complicated for the ordinary digestion and we won't attempt to concentrate a book in a paragraph. It is enough to say that the good doctors can really prove that the atoms in isomers have different relative positions and different intensity of grip, in ways that make logical reading provided you do not have to memorize them for the exam next month.

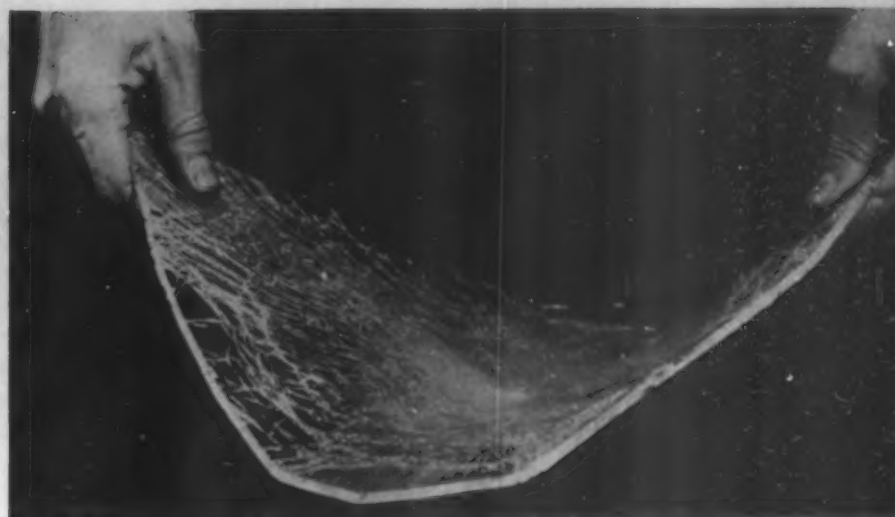
One other point is to be considered before going into the vocabulary the chemist uses, we suspect, with great delight to confuse the layman: The subject is radicals, not those that threatened to upset elections but a very useful creation of nature. Groups of atoms, such as  $CH_3$  and  $C_2H_5$  which act like single atoms, and which enter unchanged into a number of compounds, are termed radicals. The  $CH_3$  of the methyl alcohol just mentioned is a radical that comes up frequently.  $C_2H_5$  is the radical that ties up to the OH radical and forms ethyl alcohol, the grain alcohol of commerce. In our elementary chemistry, inorganic, we had the sulphate radical  $SO_4$ , which had a leaning toward hydrogen to form sulphuric acid, and the same OH radical which then liked to form potassium hydroxide with K, an abbreviation for potassium.

When the economic planners of their day started to lay out a scheme for organic chemistry, they began bravely with a very logical set-up. Soon they bogged down and started extemporizing; they even got poetic and changed a nice, easy system of numbering to make some of their names sound smoother. At least, that's the way it looks to an outsider just dropping in for a short visit as we are.

Organic chemistry is full of chains or series of compounds that have similar chemical structures and properties. These chains are arranged in the order of the number of carbon atoms contained in the molecule and the members of each chain are (Continued on page 92)



This demonstrates the water white color and transparency of a 20 percent solution of acrylic resin in an organic solvent



Sample of laminated glass that is tough and elastic and will stretch almost 1000 percent before breaking. (All photos, courtesy Röhm & Haas)

## ACRYLIC RESINS

by D. S. FREDERICK

THE ACRYLIC RESINS, POLYMERIZED DERIVATIVES of acrylic and methacrylic acids, have attracted great interest in various industries due to their many useful applications. These materials, although known to chemists for many years, have only recently been made available in commercial quantities.

Several investigators experimented with acrylic acid derivatives prior to 1900, but the industrial development of these resins was due mainly to the efforts and foresight of Dr. Otto Röhm, of Darmstadt, Germany. He published, in 1901, the results of his researches with von Pechman on the acrylic acid derivatives; since that time he has been actively engaged in the commercial development and application of these interesting products. In 1931, acrylic resins were first made available in commercial quantities in this country. They are now available as solutions in organic solvents, in aqueous emulsions, and as solid thermoplastics.

Although many of the monomeric derivatives of acrylic and methacrylic acids such as the nitriles, amides, esters, salts, and acid chlorides, polymerize to give resins, the polymeric esters are of most significance from a commercial standpoint. As the use of acrylic resins in aircraft and the properties and applications of methyl methacrylate are discussed elsewhere in this volume, this article will not be concerned with these two important subjects.

In general, the polymeric acrylic and methacrylic esters are characterized by their perfect colorless transparency, thermoplasticity, stability against aging, and

chemical resistance to many reagents. They range in consistency from soft, sticky, semi-liquids to hard, tough, thermoplastic solids. Since products of these widely varying properties can be obtained by the proper control of the manufacturing conditions, rather than by the customary use of plasticizers, the acrylic resins retain their initial properties indefinitely. The stability of the acrylic resins against the action of heat, light, and oxidizing agents also gives them the advantage of unchanged properties after aging and weathering.

The resins are prepared by the polymerization of the monomeric acrylic derivatives. The polymerization of the monomeric acrylates and methacrylates is catalyzed by the action of heat, light, oxygen, and oxygen-yielding substances such as sodium peroxide, hydrogen peroxide, and benzoyl peroxide. Anti-oxidants such as hydroquinone act as polymerization inhibitors. The polymerizations are exothermic reactions which, in every instance, must be carried out with careful temperature control to prevent their becoming violent. In general, the acrylates polymerize much more rapidly and more violently than do the methacrylates.

The polymerization of monomeric acrylic derivatives may be conducted in organic solvents, in aqueous dispersions, or the monomers may be polymerized in the absence of any diluent. The concentration of polymerization catalyst, the temperature of polymerization, and, in solution, the constitution and concentration of the solvent, all have very definite effects on the characteristics of the polymers obtained. The chemical

constitution of the monomers also has a great influence on the characteristics of the polymerization products. The polymeric esters of methacrylic acid are harder and have higher softening points than the corresponding polymeric acrylates. In general, the lower esters in both series are harder, less elastic, and have higher softening points than their higher homologues. Thus, polymethyl acrylate is a tough, pliable, elastic solid, capable of 1000 percent extension, while polybutyl acrylate is a much softer resin, tacky at room temperature. Correspondingly, polymethyl methacrylate is the hardest methacrylic ester, while n-amyl methacrylate polymer is very similar to polymethyl acrylate in its physical properties. Isomeric variations in the alcohol group also exert an influence on the physical characteristics of the polymeric esters. Tertiary butyl acrylate polymer, a tough, hard solid, is the hardest of the polybutyl acrylates; polymeric secondary butyl acrylate is similar in properties to polymethyl acrylate; polyisobutyl acrylate is softer than either of the two above-mentioned polybutyl esters, while the n-butyl ester polymer is soft and tacky as described previously.

When all the controllable modifications of polymerization conditions and chemical constitution are considered, it is evident that acrylic resins can be made to order for applications requiring widely varying properties. For example, starting with one solvent containing a definite concentration of one monomeric ester, solutions of polymer having a wide range of viscosities can be prepared. With these manufacturing controls in mind, we can better understand why the acrylic resins are suited for so many diversified applications.

#### Laminated glass

The first commercial application of acrylic resins in this country was as an intermediate layer in laminated safety glass. In this application, the extensibility and elasticity of the acrylic resin film made possible the production of a laminated glass which gave a flexible or "yielding" break when subjected to a hard impact. The excellent adhesion of the resin to glass eliminates the necessity of using a cement to bond the interlayer to the glass sheets. The resistance of the acrylic film against moisture makes unnecessary the use of a sealing compound around the

edge of the laminated sheets. The acrylic resins are also more perfectly transparent, more stable to ultra-violet light, and show greater strength at low temperatures than the cellulose plastics which have previously been used in making laminated glass. Laminated glass prepared with acrylic resins can be more easily cut than glass laminated with cellulose derivatives. These advantages of this acrylic-laminated glass have caused this material to be used extensively in motor vehicles.

The acrylic resin used in the production of laminated glass is supplied in the form of a viscous solution in an organic solvent, not as a dry resin film, which is the usual form of other plastics employed by the laminated glass industry. A film of the acrylic resin solution of carefully controlled thickness is applied to each of the glass sheets to be laminated, and the solvent evaporated by forced drying. The resin films are moistened by a suitable plasticizer and the resin-coated glass sheets placed together in such a manner as to force out all air bubbles. The laminated sheets are then subjected to a relatively low pressure to ensure a firm and uniform bond.

This comparatively simple laminating procedure eliminates the necessity of autoclaving at high temperatures and pressures, and makes easier the avoidance of contaminating dirt which always constitutes a serious problem in working with transparent plastics. Acrylic-laminated glass possesses an outstanding colorless transparency and freedom from haze which is not equalled by laminated glass made with any other plastic. The acrylic resin adheres so well to the glass, that, although no sealing compound is used around the edges of the laminated sheets, prolonged immersion in boiling water causes no delamination. Because of the stability of the acrylic resins against light, it is unnecessary to use the green glass whose protective action is so desirable in the case of plastics less stable to light rays. This permits the manufacture of a laminated glass of higher light transmission, and therefore, clearer vision.

#### Protective coatings

The excellent adhesive properties and outstanding aging resistance of the acrylic resins are of great importance in many applications besides the lamination of glass. These qualities make the acrylic resins very suitable for use as protective coatings. Films of these materials have a refractive index of approximately 1.49, and a specific gravity of about 1.15. Acrylic resin films, being completely polymerized, so that they contain no unsaturated groups, dry due to solvent evaporation.

These resins are unique in respect to their flexibility and elasticity. Acrylic resin films extensible in excess of 1000 percent may be prepared without the use of plasticizers. The films are not truly elastic, because on stretching they exhibit a certain degree of plasticity. They do not "snap back" to their original form, but require an appreciable length of time for recovery. The rate of recovery and tensile strength of the acrylic films are greatly influenced by the molecular weight (viscosity) of the polymers. Polymers of high molecular weight exhibit greater tensile strength and more rapid recovery

An unstretched film of Acryloid as compared with one to which a small clamp has been added in one case, and a 500 gram weight in the other



after extension than do lower polymers of the same chemical constitution.

In general, acrylic resin films have excellent adhesion to most surfaces. The softer polymers are always superior in this respect. Adhesion to metal surfaces may be improved by baking. The acrylic coatings are unexcelled in respect to their water-white color and permanence. The harder polymers show no discoloration, no loss of gloss, and no failure of any kind after three years' exposure to weathering and sunlight. The softer acrylic resins exhibit a somewhat inferior water resistance. The films do not discolor after long periods of internal or external exposure. Acrylic resins show good heat resistance, withstanding temperatures as high as 350 deg. F. without discoloration. Discoloration appears only after prolonged baking at temperatures sufficiently high to cause pyrolysis. When ignited, acrylic films burn slowly, being very similar to cellulose acetate in this property.

The resistance of these films against water and chemical reagents varies with the type of polymer. The harder resin films are not affected by alkali, sulphuric acid, hydrochloric acid, or acetic acid at room temperature, and show an excellent resistance to both cold and boiling water. The softer polymers are slightly less stable to these reagents. On continued heating in water at 212 deg. F., the harder films are not attacked, but their adhesion is somewhat reduced. The acrylic resins in general are unaffected by petroleum oils, gasoline, greases, and petroleum hydrocarbons, are soluble in aromatic hydrocarbons, esters, and chlorinated hydrocarbons.

These resins exhibit limited compatibility with natural occurring resins and other synthetic polymers. Rather unexpectedly, many of the acrylic polymers are not compatible with each other. It has been found that  $\frac{1}{2}$  second nitro cellulose is compatible with acrylic resins in all proportions, although cellulose acetate has very limited compatibility. The ethyl- and benzylcellulose ethers are incompatible. Castor oil, shellac, cumar, dammar, ester gum, and rosin have limited compatibilities. Of the other synthetic resins, those of the phenol-formaldehyde, vinyl, and maleic acid types are somewhat compatible. Alkyd resins, drying oils, and clear resinous varnishes are incompatible. Since the acrylic resins are completely neutral, any type of pigment may be used with them without fear of reactivity. The permanent water-white color of the polymers enables them to be used in the formulation of pigmented white finishes which will not discolor.

As solutions of various viscosities and resin concentrations are available, coatings of the acrylic polymers may be applied by brushing, spraying, or dipping. These coatings are recommended for use where their outstanding properties of water-white color, non-yellowing, petroleum and oil resistance, good electrical properties, adhesion, ozone and chemical resistance, etc., are of importance. Specifically, their application in the field of clear metal lacquers, textiles and artificial leather, electrical insulation, coatings on rubber, glass, lamp-

shades, porous surfaces, containers, and chemically resistant coatings appear promising.

### Leather finishes

An important use of acrylic ester polymers has been developed in the field of finishing genuine leather. On account of the uses to which leather is put, the requirements in this field for adhesion and permanent flexibility are especially high, and many coating materials, successful in other industrial finishing fields, have failed to yield satisfactory results in leather finishing.

In this field, aqueous dispersions of the softer acrylic polymers are used almost exclusively. The coatings are frequently pigmented and are applied to the grain of the leather by hand. The resulting finishes have outstanding flexibility and adhesion, without in any way detracting from the natural "feel" and appearance of the leather. The preservation of a natural character is highly desirable in finishing genuine leather, and it has been in their inability to do this that many coating compositions, excellent from the standpoint of pure utility and protective effect, have been unsatisfactory in the leather finishing field. The use of acrylic ester polymers for this application is growing rapidly, and will undoubtedly become much wider than it is even today.

### Electrical uses

The excellent electrical properties of the acrylic resins suggest their use in the electrical field. As the monomers are mobile liquids which can be forced into small apertures and polymerized *in situ* to tough, water-resistant solids, they are useful as impregnating agents for electric coils. Their application for this purpose is somewhat restricted due to the volatility of the monomers and their shrinkage during polymerization.

The softer acrylic polymers may be compounded on a rubber mill with fillers such as talc and carbon black to give tough elastic solids which can be extruded in the same manner as rubber. These filled resins have been used as protective coverings for electrical conductors, where their light weight and flexibility give them advantages over the usual lead coverings. As they have excellent oil and ozone resistance, they are also useful in place of rubber in many electrical applications.

### Adhesives

The permanence of their properties and their excellent adhesion to all types of materials make the acrylic resins of use as thermoplastic binders. Surfaces to be bonded are coated with an acrylic film and then sealed together under heat and a slight pressure. The flexibility and extensibility of the acrylic adhesives make them suitable as binding agents where the bonded materials are subject to flexure and elongation. Wood, metals, textiles, rubber, glass, and other materials may be cemented together with these thermoplastics.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

# APPLICATIONS OF ALKYD RESINS

by C. S. FERGUSON

THE VERSATILITY OF MODERN OIL MODIFIED alkyd resins in finishing materials can best be shown by relating some of the better known applications that by test of time have proved to be successful. It is well known that a relatively few years ago when resins of this type first became commercially available, they were looked upon as somewhat desirable for use in baking enamels but little attention was given to their possible use in air drying finishes. Although early tests demonstrated rapid drying and extreme resistance to weather, they were considered decidedly lacking in water resistance and too unstable for use in shelf goods or even in industrial finishes, unless it was certain they would be applied soon after the products were manufactured.

These deficiencies have long since been remedied. A more complete investigation of raw materials resulting in modern formulations, a thorough study of processing in equipment especially designed for the manufacture of alkyd resins and close cooperation with technicians who by training and experience are qualified to produce better protective and decorative finishes, have made possible the tremendous increase in the use of these resins and, as we shall see, the diversity of applications. It is standard practice today to apply clear or pigmented coatings, the vehicles of which are alkyd resin solutions, by brush, spray or dip methods, and they may be suitably formulated for air drying or baking.

Among the most successful baking finishes made with alkyd resins is white refrigerator enamels. Much is required of such a finish and few if any other types of finishes are subjected to such an array of severe tests. It must bake to a high gloss, flow out smoothly and possess sufficient toughness and flexibility to prevent chipping, yet it must not discolor appreciably during baking. It must possess excellent resistance to humidity, to grease, to color change due to heat, light or darkness, and resist fumes. In addition, the film must be, to a fair degree, weatherproof. It is only necessary to observe the variety of refrigerators now finished with alkyd resin coatings to discover how well these tests have been met.

In view of the ability of these finishes to meet such requirements, it is obvious then that their increasing use is found on hospital equipment, white enameled metal furniture, metal beds, kitchen supplies and hardware.

Among the better known properties of alkyd resins are durability and gloss retention or, better, original appearance retention. Many finishes used prior to alkyd resins, upon exposure to weather would still be protective long after their appearance would be in deplorable condition due to early loss of gloss, fading, chalking or

other discoloration. With properly formulated alkyd resin enamels, it is possible to balance very closely the decorative and protective effects so that early refinishing to restore original appearance is not necessary. This readily explains the popularity of alkyd resin finishes on transportation equipment, railway and street cars, buses, automobiles, motor trucks, gasoline pumps and service station equipment, metal signs, farm implements and bicycles. For similar reasons these vehicles are also found in the composition of finishes for wire, wood and metal fences, automobile license plates, flower boxes, metal sash, roof paints, lamp posts, traffic signals, lawn and porch furniture and many others too numerous to mention. Many of the better grades of trim and trellis paints also contain alkyd resin vehicles.

Another very important characteristic of these resins is heat resistance and therefore it is quite natural to find them used extensively in coatings for boilers and furnaces, furnace ducts and radiators, water heaters, stacks, lamp reflectors and in finishes for gas engines.

In the field of structural and ornamental steel we find specifications including alkyd resin vehicles in the formulation of paints for bridges and other large steel structures and in metal priming paints. Exceptional adhesion and long life prompt writing these into the specifications. They are used in large volume in finishes for other metal products such as lawn mowers and garden tools, highway markers, wheelbarrows and stokers.

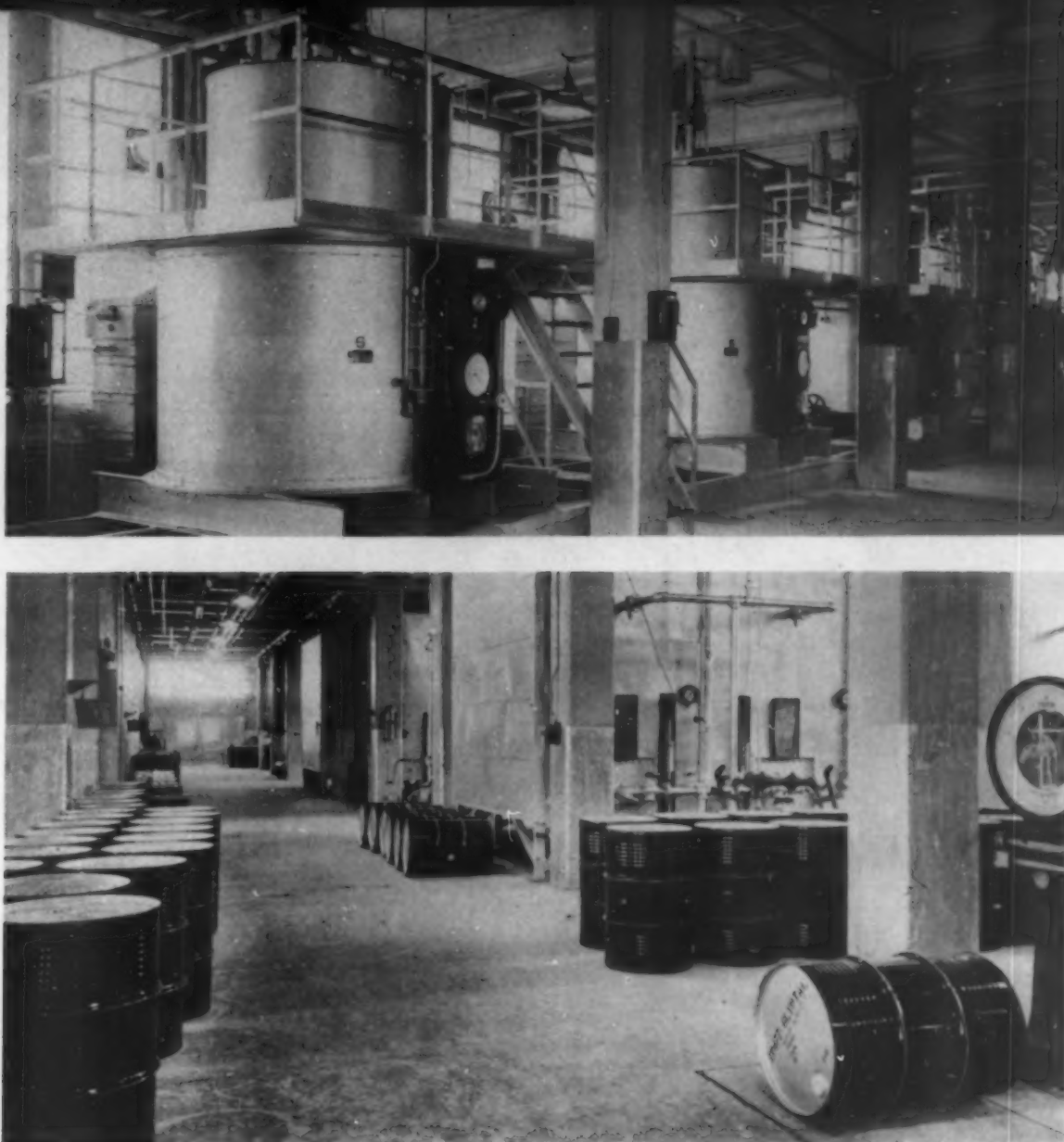
As vehicles in machine tool finishes they are valued for their oil resistance, toughness and adhesion. Mar resistance and toughness also account for their use on metal furniture.

A particular use demonstrating the extreme flexibility and long life of oil modified alkyd resins is that of coatings for silk and other fabrics used in the manufacture of rain coats, tobacco pouches, insulating materials, etc.

As baking improves certain properties of refrigerator finishes, it also increases resistance to soap and water, which is one of the principal reasons for the use of alkyd resin enamels on washing machines and other laundry equipment. It also is responsible in part for their use in collapsible tube coatings.

A sizable volume of alkyd resins is now present in marine finishes, especially those subjected to extreme conditions of exposure, heat and salt water. Indications are that their use in this particular field will increase considerably during the next few years.

If further proof of versatility is necessary, it might be mentioned that especially designed alkyd resins are used in lithographing, tin decorating and in printing inks—



Two views of the manufacturing plant where alkyd resins are made (Photos, courtesy General Electric Co.)

these applications requiring somewhat unusual characteristics. Coatings for golf balls, lamp shades, compacts, toys and novelties also add to the variety of articles protected or decorated with alkyd resin finishes.

A tremendous volume of finishing materials is used in building interiors and it is in this particular field that alkyd resins are now being seriously considered. In fact, a number of architectural finishes containing these resins have already appeared on the market. Improved vehicles are available, which, when incorporated in gloss, semi-gloss or flat paints are easy working, possess excellent flow and appearance and are practically free from after yellowing. They also dry quickly and are easy to keep clean. Undoubtedly this will add greatly to the already huge quantity of alkyd resins used in finishing materials.

Although practically all of the discussion thus far has dealt with the applications of drying or semi-drying oil modified alkyd resin solutions as the sole vehicles, it should not be overlooked that many modifications of these resins are also important components of nitrocellu-

lose lacquers. Due to the flexibility and toughness of these resins, a higher ratio of resin to nitrocellulose can be used without impairing flexibility of the lacquer film, thus greatly improving film building and gloss. Attempts to accomplish this with natural resins result in brittleness and decreased durability. Weather resistance is also improved and, as mentioned before, they assist in maintaining the original appearance in spite of severe weather exposure. Such lacquers also exhibit improved resistance to oil and alcohol. In wood lacquers, alkyd resins of special design make possible ease of rubbing.

Manufacturers of adhesives and paper coatings are also actively interested in the possibilities of these resins and as time goes on further developments will introduce them in various other fields of usefulness. The alkyd resin industry is still young and continued research will result in further refinements of these resins and a natural expansion of their use.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

# CASEIN PLASTICS

by C. S. LAWRENCE

BUTTONS, BUCKLES, SLIDES AND ACCESSORY trimmings continue to be the principal articles for which casein plastics are used, and greater quantities of these items are being made than ever before. Casein plastic material has definitely proved its worth in this field and has held its own against other materials. It is strong, and the colors are permanent and durable when they are incorporated in the material during manufacture.

Casein material may be dyed after polishing with remarkable success. This makes it possible to produce articles in large quantities in one color which can then be dyed to any color desired. Multicolor effects may be obtained by dyeing and recutting. Most polishing is now done by the "Chemical" or "Dip" polishing process which is dipping the articles to be polished in a hypochloride solution resulting in a low polishing cost.

Many manufacturers are using punched, sliced and turned disks or blanks, also punched buckles, slides and other shapes. These items are formed while the material is in the uncured state and are then hardened. The waste which formerly resulted from the making of these

articles from sheets and rods is eliminated by this process as the uncured waste material is reworked.

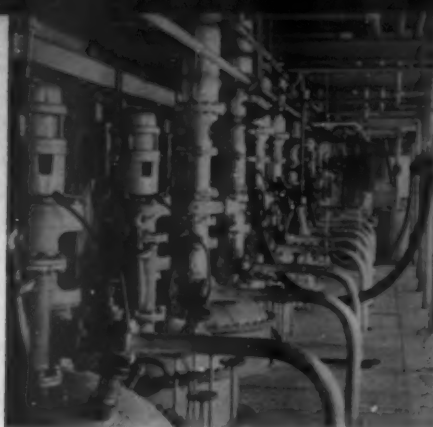
Considerable progress has also been made in forming articles under pressure from both cured and uncured material. This eliminates the operation of carving or machining shapes and designs, and articles made in this manner are satisfactory for many purposes. The various processes are not altogether new, but the increased use of casein has justified the expense involved in the development of these methods and mechanical equipment may be obtained without difficulty to do the work.

There is a continued increase in the use of casein plastic rods for parts and colored trimmings made on automatic screw machines by the manufacturers of radio and electrical apparatus and appliances. Manufacturers of games, musical instruments, knitting needles, manicure sticks, buttons, buckles and pocketbook trimmings are important users of casein plastics.

**Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.**

Casein plastics are used in a wide variety of applications of which those in the photograph are typical. (Photo, courtesy American Plastics Corp.)





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6

CATALIN

1. Cast resins are reacted in this battery of solid nickel kettles, where they are heated by steam jackets and dehydrated by vacuum. 2. Liquid cast resin being poured into lead molds. 3. When mottled colors are desired they are stirred into the base color by hand. 4. Dipping and stripping lead molds from the arbor. 5. Castings are removed from molds with pneumatic hammers. 6. Sheet stock is sliced from large blocks which have been partly cured. (Photos, courtesy Warner Bros. Vitaphone Pictorial Review)

## CAST PHENOLIC RESINS

by D. K. BANCROFT

NO ONE MATERIAL, WHETHER NATURAL OR man-made, possesses the ideal physical or chemical properties necessary to meet all the complex requirements of modern industry. The inherent deficiencies of any material, whether old or new, provide the incentive for a vast army of chemists who search untiringly for a suitable compromise. They work with substances nature has already lavishly provided and by adding to them, by combining or processing them, oftentimes entirely new products are brought to light, in many instances with better properties than any natural materials.

Cast phenolic resins, one of the younger man-made materials, like any other product are not universal. They require consistent study and thought on the part of the chemist, engineer and designer to ensure their being applied intelligently and with real benefit to the product being considered. But thousands of dollars spent each year in research and development work have brought them to a degree of perfection where they may

be used profitably over a broad range of diversified applications. During the current year alone, the versatility of these materials has been unquestionably demonstrated by the fact that they have become fixed in several new industries which heretofore have generally been considered beyond the reach of this type of plastic. Industry as a whole is vitally interested in the development of any new material, judging it in terms of their own products, but in order to appreciate the possibilities of such new substances, it is necessary to comprehend fully their nature, properties and limitations by first hand information as to what they are made of, how they are made and where they may be used to advantage.

Cast phenolic resins depend upon synthetic substances produced from coal for their origin. For years coal was used only as a fuel; then science discovered that it embodied other primary materials which could be extracted and used in activities far removed from the mere providing of heat. Coal tar, for example, is derived from coal

by destructive distillation at high temperatures, and a further distillation of coal tar results in the extraction of light, middle, heavy and anthracene oils. The middle oils contain phenol which is the principal ingredient of cast resins, and from anthracene oils is distilled aniline dyes used for coloring them. Formaldehyde, the other major ingredient, is a derivative of synthetic wood alcohol. To the phenol and formaldehyde are added catalysts such as distilled water, caustic soda and an acid solution to neutralize the soda. The catalysts bring the phenol and formaldehyde molecules together until they completely lose their individual identity and become a new character entirely.

The proportion of each ingredient, the cooking period, and curing time varies in accordance with the color and chemical properties desired to best fulfill the requirements of products to be made from finished material. The base mixture for ivory and white, for example, differs from that used to produce colors; still another base is necessary for water clear, and no one of these clear or colored materials can be produced except by using the special base developed for it. The industrial application must also be considered in preparing the base. As an illustration, a base for the manufacture of brush backs must

be modified to provide a material with the necessary elasticity to take the strain of the stapling operation. Separate tufts of bristles must enter a hole in the plastic that is actually smaller in diameter than the combination of bristles and the plunger, and the cast resin therefore must be pliable enough to stretch sufficiently to accommodate them.

The raw ingredients are weighed in correct proportions and flowed into huge kettles about 8 or 9 feet high, with an approximate capacity of 1,500 to 1,800 pounds of finished resin. A balcony through which the dome shaped cover projects, affords convenient working facilities for filling the kettles, which are steel jacketed outside and lined with pure nickel inside. Incidentally, any metal that comes in contact with the resin and chemicals is of nickel. The resin, cooked at a comparatively low temperature and dehydrated by vacuum created by individually motor driven pumps, is agitated from 18 to 20 hours or until it reaches the consistency and color of honey. At this point coloring matter is added and the resins are further agitated so that the color is uniform throughout the mixture. This continues under constant supervision until the resins are ready to pour, which represents a critical moment in processing the liquid, because once it has reached the stage where it is ready to "kick over," polymerization starts to set in, and the resin must be quickly transferred to molds prepared in advance. Skilled workmen know from experience about how long it takes for a given number of pounds of raw materials to be processed to the desired consistency and as the time limit approaches, small quantities of liquid are extracted from the kettle every few minutes and tested in cold water. This makes it possible to ascertain the exact moment when the resin should be poured. After each batch has been mixed and cooked, the kettle is washed inside with a caustic soda solution and scraped until it shines, to make ready for the next batch.

The material thus obtained may be transparent, translucent or opaque in colors ranging from transparent, colorless water white to black, white, ivory, delicate pastels and vivid hues, and in addition, they are often matched to meet specifications of users. Two or more color combinations can be produced, with the colors either distinctly divided or blended by mottling. Mottled or multi-color effects are obtained by mixing colors of the same specific gravity, prepared in the same manner in smaller kettles, into the base color. This is strictly a hand operation and the beauty of the finished material depends upon the way in which the mottling color is dispersed throughout the mixture. The base color flows from the kettles into large saucepans and is immediately brought to the mottling operator who proceeds to dip a rod, that has been immersed in the mottling liquid, once, twice or three times into the mixing vessel, turning it in a rotating or criss-cross motion or framing a star. When the vessel is tipped to pour the liquid into the mold, the vari-colored lines converge slowly and evenly and remain fairly uniform from top to bottom of the casting.

After the liquid resin is poured into molds, it is cured in ovens or vulcanizers under accurately controlled tem-

7. Buttons and buckles in every color and effect are virtually unbreakable.
8. Counter display, nut conditioning and selling device of cast resin mounted on a glass base.
9. Lining in the interior keeps nuts at the desired temperature, preventing their becoming stale.
9. Transparent cast resinoid is used for the cylinder of Hill's-McCanna metering site feed assembly

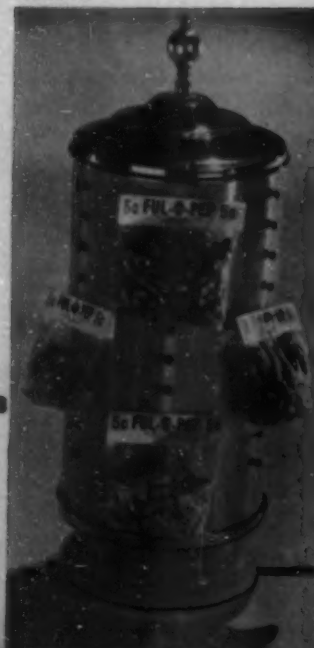
DU PONT

7



FIBERLOID

BAKELITE



9



MARBLETTE

The modern clock at the top of this picture as well as the poker chips and checkers below, are fabricated from stock cast resin shapes

perature until it is fully polymerized and acquires the proper hardness. This curing operation is another important step in the process, for under-cured resins are soft and inclined to become brittle with aging, while over-cured materials may be too hard to have proper machining qualities; there is also danger of colors changing if the cure is carried too long, particularly with pastels, for the dyes are sensitive and may undergo some change through too long exposure. The curing period varies from four to twelve days depending on the base resin and the purpose for which it is to be used. White and ivory are cured in the least time, requiring about four days while water clear and transparent colors require the longest curing time. When the molds are removed from the vulcanizers the castings are ejected with the aid of pneumatic hammers, and are immediately ready for shipment and fabrication.

The castings are available in many forms which make possible the fabrication of thousands of diversified items with a minimum of machining and material loss, and these may be either stock designs or those specified by fabricators. Stock rods may be round, square, triangular, fluted or otherwise shaped for convenient use, varying from  $\frac{1}{4}$  in. to  $5\frac{1}{4}$  in. in diameter, and are usually supplied in 20-in. lengths. Cylinders are ordinarily cast in 10-in. lengths with outside diameters ranging from 1 in. to  $8\frac{7}{8}$  in. These may be of any specified outside contour such as round, square, fluted, etc., and cored with one or a multiple of holes from end to end, to facilitate machining operations. Such cored cylinders are used in the production of belt buckles and slides, bracelets, rings and other costume jewelry, as well as for washers and bushings used industrially. Castings in the form of letters of the alphabet, which are used in sign making and advertising displays, afford an interesting example of the utility of cylinder forms. These are cast with a single core for the letter "O," a double core for the letter "B" and open end cores for the letters "M," "W," "S," etc. Sliced to the desired thickness, the slices form finished letters which with a minimum of polishing are ready to be mounted in frames or holders for use.

The lead molds for casting rods and cylinders are

formed by dipping master steel patterns into molten lead. The lead "freezes" around the steel and is stripped off giving a negative mold. These lead molds are arranged in racks for convenient transportation about the plant and are used but once, after which they are re-melted. A recent innovation in casting small round shapes has been the use of glass molds, which in themselves are extremely thin. They are filled with liquid resin—which may be poured at a low enough temperature so that it doesn't affect the thinnest glass—cured in the usual manner and subsequently the glass mold or shell is easily broken away leaving a surface on the plastic as smooth as the glass itself, so that no polishing of any kind is required. Practically any shape could be molded in glass if it were not for the definite limitation of cost. The glass molds currently used are standard items, which are produced by the hundreds of millions in automatic glass blowing machines. The volume of these is so tremendous that the price is relatively low and within the means of the fabricator. Special sizes or any shape not covered by standard shapes would require special steel dies for blowing the glass, and then because the runs would be relatively small, the cost of the glass mold would amount to more than the material and labor saved. Consequently, it is more feasible to turn such objects from solid rod stock.

Sheets of cast phenolic are made by pouring liquid resin into a large tin box which is rolled into the vulcanizer and allowed to remain until the resin is brought to a point of cure where it has the consistency and elasticity of rubber. The block is then removed from the vulcanizer and sliced into sheets of desired thickness by means of a hydraulic knife. As the sheets curl off the knife they are piled one on top of the other, separated only by wax paper, and a heavy weight is placed on top to prevent warping. The stack of sheets is returned to the vulcanizer for additional curing which is completed in approximately ten days. Cut sheets have a frosted appearance and must, therefore, be polished by the fabricator to restore their natural luster and beauty. Fully polished sheets can be made by pouring liquid resin between plates of glass set in a (Continued on page 17)

# CELLULOSE ACETATE PLASTICS

by BJORN ANDERSEN

CELLULOSE ACETATE PLASTICS HAVE SHOWN A tremendous growth during the past few years, the annual percentage increase being greater than for any other commercial plastic. Still this is only the beginning. It does not require much vision, to picture a far greater future for cellulose acetate plastics, when one has a full appreciation of their unique properties and versatility.

The world's first plastic, Celluloid, is said to have had more than 25,000 different types of applications. We are all familiar with many of its uses. Cellulose acetate is the ester of cellulose and acetic acid while Celluloid is a pyroxylin plastic in which the main ingredient is cellulose nitrate, the ester of cellulose and nitric acid. You conclude, therefore, that these two plastics belong to the same family, and you are right. Only cellulose acetate is of the new generation. It has inherited all the good properties of the old "granddaddy" without inheriting undesirable ones. In addition it has other properties, permitting a much wider utilization than the pyroxylin plastics ever could enjoy. We may, therefore, see cellulose acetate plastics replace the "25,000 applications" of pyroxylin plastics. In a large measure this has already been accomplished with more satisfactory results.

Let us look over the main virtues of cellulose acetate plastic which we might list as follows:

1. It is almost as clear as glass and will transmit 80 to 90 percent of the visible light in a sheet  $\frac{1}{8}$  in. thick.
2. It has very good light stability and one year's outside exposure to sun and weather in our climate will leave its color practically unchanged.
3. It can be given any color desired, in transparent, translucent or opaque, and from the softest pastel to the brilliant hues.
4. It is truly thermoplastic and can be readily shaped, formed or molded by any known methods.
5. If it burns, it burns only slowly and is less of a fire hazard than the newspaper and furniture in your home.
6. It is exceptionally strong and tough and will withstand great impacts without breaking and splintering.
7. Cellulose acetate plastic has a high dielectric strength and a fair power factor. It is an exceptionally desirable insulating material for many electrical applications.
8. It retains a high polish, can easily be kept clean and is not spotted by grease, mineral oils and fats.

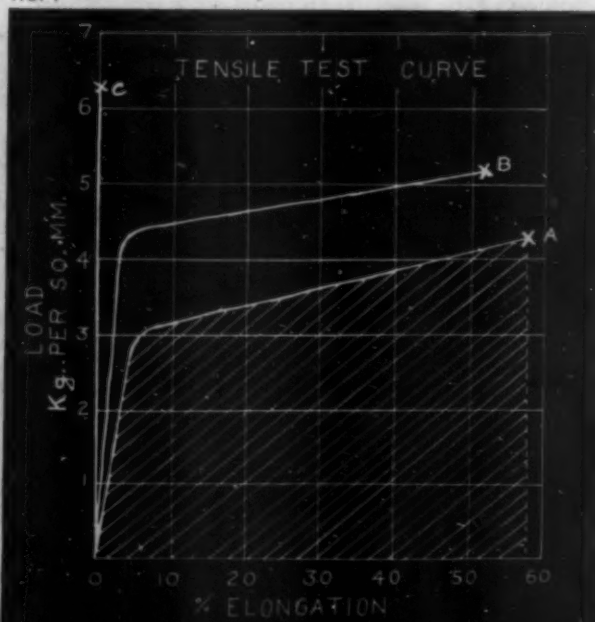
The actual physical data for cellulose acetate plastics are given in the Plastics Properties Chart and will

not be repeated here. But I do want to clarify item 6, since there seems to be a general misconception of the term—"Strength or Toughness" when applied to plastics.

Very often you hear the statement that such and such a product is very strong and tough since it has a high tensile strength. This is not so. Tensile strength alone is not a measure for toughness. The tensile strength of plastics when determined at freezing temperature will be considerably higher than when measured at room temperature. But we are all familiar with the fact that a plastic product is more brittle and fragile or less "tough" at the low temperature in spite of the higher tensile strength it showed. Tensile strength alone, therefore, does not tell the story. Tensile strength and elongation must be considered together; either one is misleading when considered by itself. To clarify this statement it is necessary to have some idea of how the test is made and the significance of the values obtained. In a tensile machine the test piece of the plastic product is clamped between two jaws which are pulled apart until the sample breaks. The force separating the two jaws is increased at a steady rate, and the machine records the elongation of the sample for any given load until the test piece breaks. To get a better idea of what the tensile machine tells us, Fig. 1 illustrates three different tensile test curves, plotting the applied force against the elongation of the sample. Curve A represents a medium hard cellulose acetate plastic sheet formula, curve B a hard cellulose acetate plastic formula and for comparison we are showing curve C representing a commercial non-cellulosic plastic product.

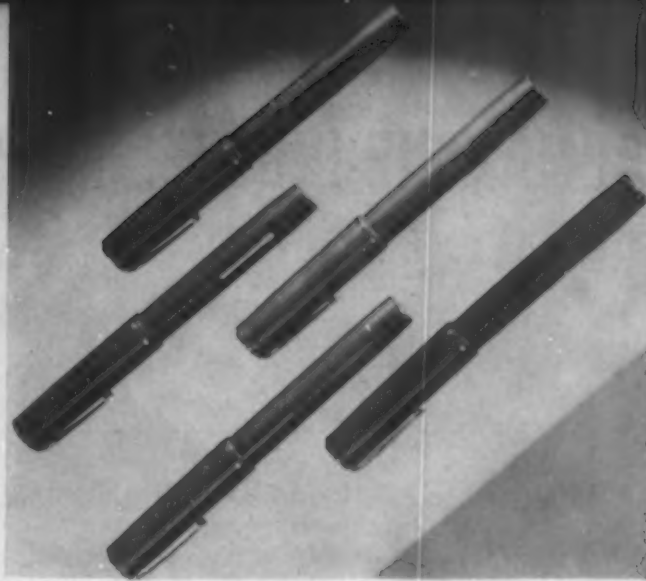
If we follow curve A from its starting point we find that the tensile machine shows us the percentage elongation of the test piece for any given force. As we increase the force or load the elongation is increased also, until finally we reach the end of the curve. At this point the

FIG. 1





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2. Pottery lamp topped with nail head finish Lumarith in Cannes rust. 3. Cellulose acetate pens injection molded by H. P. & E. Day for Esterbrook Pen Manufacturing Co. 4. Toilet accessories molded of cellulose acetate. 5. Automobile hardware is available in colors that harmonize with upholstery and interior appointments (Photos courtesy Celluloid Corp.)

test piece breaks, and the elongation and the force applied have reached their maximum values. These values are referred to as "Percent Elongation" and "Tensile Strength" of the product tested. The first point to note in interpreting tensile data is that the tensile strength (load or force at break point) is not the true measure of the tendency of the test piece to break. To break the sample of the material we are testing, we not only have to exert a sufficient *force* on it, but that force must act through a sufficient *distance* on the sample. That is, you must do enough *work* to break the material. Work is defined in mechanics as force times the distance through which that force acts. If a force acts through a distance insufficient to supply the work necessary to break a sheet, the sheet remains intact. The *work* required to break the test piece is the important factor in determining the material's ability to stand abuse, and is the true measure for "*toughness*."

If we again look at Fig. 1, we find, that we can calculate from the tensile test curves this work which is the most important value obtained from this test. Look at curves A, B and C representing three different samples. If we draw a line from the end point of each curve per-

pendicular on the base line, the law of mechanics tells us that the work expended to break the respective samples is proportional to the area encompassed by the tensile curve, the base line and the perpendicular from the end of the curve to the base line. In the case of material A Fig. 1 shows this area shaded. To simplify the determination of "the work" when we know the tensile curve, we can make an approximation of it by multiplying the tensile strength (load at break point in kg. per sq. mm.) by the elongation at break (in percent) and call it *tensile product*. The importance of this value may be illustrated by comparing the properties of the cellulose acetate plastic A and of the resin represented by curve C.

The *tensile product* of A, we note, is about 250 and of the product C is practically zero. To see what this means in terms of a practical breakage test, take strips of each material, say 1 in. by 6 in., and support them at each end an inch above the surface of the table. On striking them in the center with the fist, C will break even if  $\frac{1}{8}$  in. thick, while the cellulose acetate plastic A will not. Due to the high *tensile product* of A there is not enough work put into it by our blow to break it.—Several other plastics will show tensile curves (Continued on page 69)

# COUMARONE-INDENE, A THERMOPLASTIC RESIN

by JOHN A. KENNEY

THE COUMARONE-INDENE RESINS WERE AMONG the first—if not actually the first—synthetic thermoplastic resins to achieve commercial importance in the United States. Since their introduction the utilization of the resins has steadily increased in ever widening fields. An impressive record for a new and growing industry was made in 1936 when about 38,000,000 square feet of mastic floor tile were laid in various buildings in the United States. This is interesting not only because of its growth but also because the mastic tile industry is based on the use of a thermoplastic binder. A large percentage of the binder in the lighter colored tile contains as a principal ingredient coumarone-indene resin which meets the rigid requirements of this field.

The most important requirement is that it fulfill faithfully the true definition of the thermoplastic in its behavior toward heat.<sup>1</sup> It must be permanently heat fusible or softening and must harden again when cooled. It is also desirable that the resin have good resistance to water, acids and alkalis. Other uses necessitate other properties. High electrical resistance and low power factor under conditions of high humidity are important requisites. An advantageous characteristic is that of high decomposition temperature, or heat resistance.

In many other plastic lines a suitable thermoplastic resin is required and, to receive consideration by the technologist, must have a combination of properties that are well understood and carefully standardized. Coumarone-indene resins possess these qualities together with many other useful properties upon which is based their practical employment in diversified plastic products. Additional important characteristics worth considering include neutrality, resistance to alcohol and a wide range of compatibility with many other compounding materials. The range of melting points obtained in the coumarone-indene polymers is of vital interest to the formulator requiring a thermoplastic material. These resins are available in carefully standardized stages ranging from viscous and soft or plastic, through semi-hard to hard light colored grades. The average specific gravity of the various grades is 1.08. A survey of the many industrial uses of coumarone-indene resins confirms the salient fact that one of their most valuable functions is their ability to blend with other materials which makes possible new compounds with unique properties and added commercial value.

Mastic floor tile as originally manufactured was based on the use of asphalt as a binder. It was apparent that extended use of this type flooring would be possible only

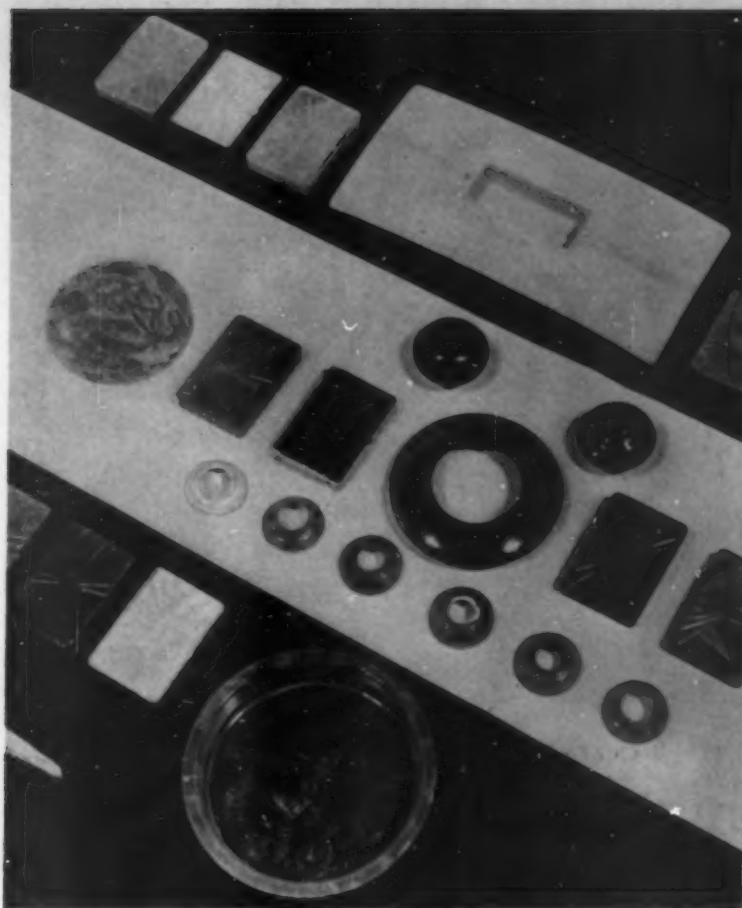
if a complete assortment of plain and variegated colors was available. With asphalt binder a subdued range of colors was possible only when a heavy complement of pigment was used.

Coumarone-indene resin is particularly adapted for tile because it has low tinting power and makes possible the production of light colored tile. It permits the use of a minimum amount of color, which is the most expensive ingredient of the composition. The alkali resistance of this resin is important because the tile is often subjected in use to alkaline cleaners and, in sub-grade installations, to alkaline waters. Other important economies favoring the use of this thermoplastic resin are savings in production time, power costs and the reworking of scrap.

To produce tile base, coumarone-indene resin is plasticized with various selected animal or vegetable pitches, or specially processed oils. In this manner a binder satisfactory in physical properties and light in color is obtained. The binder, the fibrous and granular mineral filler and the pigment are masticated on hot mixing rolls, or in heated internal mixers of the Banbury type. They are subsequently sheeted while hot through sheeting rolls. The sheets are then polished and cut into squares. The quality of the tile depends not only on the raw material but also on the technique of compounding.

The qualities which make coumarone-indene resin valuable in the tile industry render it attractive as a binder in hot and in cold molded plastics. The chemical resistance, dielectric strength (approximately 1400 volts per mil) and wide compatibility have been additional features recommending its use in plastics. The value of this resin in the molding of commutator brushes and other molded electrical conducting carbons has been mentioned by McCoy.<sup>2</sup> Subsequent baking, first at low and then at very high temperatures, serves to carbonize the resin leaving a bonded conductor with its structure intact. Soft coumarone-indene resins, modified with similar thermoplastics, have found use as binder for metallic powders which are subsequently formed under pressure into magnetic cores of high permeability.<sup>3</sup>

Preparation of molded insulation materials from a pulp of asbestos or other fibrous material and a solution of coumarone-indene resin with china wood oil in benzol has been disclosed. Pre-molding, expulsion of solvent and final hot molding and baking treatments have been employed.<sup>4</sup> In the field of cold molded plastics, coumarone-indene resin has proved of great value because of its stability under heat, its facile blending with modifying materials and its (Continued on page 114)



These ethylcellulose plastic moldings are made in molds built for and used on other plastic materials. This should give some indication of the adaptability of the material (All photos courtesy Dow Chemical Co.)

## ETHYLCELLULOSE—A NEW PLASTIC

by DONALD A. GIBB

WHEN THE MOTHER OF A GENERATION OR SO ago undertook to administer a bit of correction to her erring son, many of us can remember that she used the old, wood-backed hair brush rather than the treasured ivory colored new one made of that novel stuff called "Celluloid." For, while Hyatt's original work on this material was done many years earlier, the product was expensive at first, and goods made from it were for many years definitely in the deluxe class, and not to be risked in such strenuous service.

The popularity and wide use of plastic products in their not too distant early days was restricted by a number of factors in addition to their high cost. Some of the more important factors were the lack of knowledge on the part of molders as to the technique of handling the materials; the primitive state of such tech-

nique; the want of machinery for economical fabrication; the monochromatic and drab character of the public taste, and inherent characteristics of the available materials themselves which unfitted them for wide use.

It is only natural that as demand for plastics grew the cost declined, and the technique and facilities for their fabrication into useful and beautiful articles rapidly improved and increased.

The character of the public taste also underwent a change along with, and in part because of, the development of plastics. Plastics ceased to be a substitute for, or an imitation of something else. Ivory gave way to color, first to color in the hands of the layman, then to color in the hands of the artist. The designer supplemented the artist, and the public taste, largely through the influence of this new me- (Continued on page 112)



## FURFURAL AS A CHEMURGIC PRODUCT

by E. E. NOVOTNY

FURFURAL, THE FIRST AND TODAY ONE OF THE most important truly chemurgic by-products, depends on the utilization of pentosan-containing cellulosic materials of annual growth and at the present time utilizing a large tonnage of oat hulls. This chemical has been produced commercially since about 1920, has proved its industrial value and has shown that the demand is built up on the basis of sound commercial needs attributable to its exceptional and diverse utilizable qualifications. The almost inexhaustible annual growth of these cellulosic materials, the increasing requirements for this chemical and the fact that such increased use will directly or indirectly aid the farmer, provide a firm foundation for the utilization of more of this cellulosic waste, which means a direct increase in revenue for the farm, and the promotion of new lines of activity in industry. The outline of early production appears briefly in my previous article in *MODERN PLASTICS*.<sup>1</sup>

### Demand growing

The diverse attributes of furfural, broadly stated in the preceding paragraph, would naturally be indicative of increased demand. It is evident that oat hulls cannot remain as the sole source of furfural and that increasing demand and such divergence of uses call for the utilization of other cellulosic materials of annual growth, like corn cobs, rice hulls, peanut shells, cotton seed bran and

bagasse fibers and liquors. The available supply is enormous, the production of furfural is simple and the yield is economically high, thus where a large scale accumulation of these waste products exists furfural should be produced cheaply. Tentative plans are now being made for the production of furfural from cotton seed bran and bagasse fiber liquors. The useful adaptability of furfural, however, is such that this production will hardly be offered to the general market, fulfilling a requirement within the industry itself. The broad general demand for furfural requires the utilization of other furfural-yielding materials and the conservation program calls for the utilization of all this cellulosic waste.

### The farmers' aid

It has been stated here that the farmer derives both direct and indirect returns from the utilization of furfural-producing cellulose and while direct benefits can be readily visualized, it is the indirect benefits which have been of greatest importance to him. Furfural has made possible the purchase of what otherwise would have been luxuries and which have become economies and necessities. Numerous mechanical and electrical accessories utilizable also by the farmer, either due to the use of furfural resin as a part of the product itself or the use of furfural or furfural resin in a method or as a means of

processing or as an accessory used by the producer of the part, are finding a place in the farmers' economic cycle.

#### Typical examples

1. Furfural-phenol resins freeze—or as better known, set—to rigid infusibility when formed under heat and pressure to a product faithfully reproducing with exactness contours, dimensions and finish. The products are of great mechanical strength, high dielectric or electrical insulating properties, and are free from odor. Such products molded in various forms may be found in the automobile, the tractor and the motor. Even the incandescent lamp utilizes a heat-setting cement which holds the brass ferrule tenaciously to the glass bulb. Indeed, there are many shapes and forms where furfural may clearly be recognized as having entered into the structure or portion of structure. It is to be expected that these furfural-phenol resins may enter only partially into a structure and still be readily evident as in the insulation in many of the radios in use on the farm.

2. The super-clarified lubricating oils also used on the farm in internal combustion engines and otherwise depend upon furfural as a processing medium. This furfural is not a part of the oil which is purchased, but the furfural has been used as a clarifying medium to eliminate impurities and gum-forming substances which would do more harm than good as a lubricating medium, and for this purpose exceedingly large quantities of furfural are required annually.

3. Mass production has made necessities of luxuries and has been applied in the manufacture of automobiles, tractors, electrical equipment, refrigerators, etc., and furfural has been a great contributor toward the achievement of this program. Mass production indicates a conveyor assembly line moving with synchronous regularity with each part assembling and functioning in a precise predetermined manner. However, "if" and "but" enter into this picture in that an endless flow of individual precision parts are needed and these parts call for microdimensional accuracy without assembly tooling, peening and filing. Synthetic resins of furfural or including furfural were called upon to provide not only accurately molded parts but also a precision shaped abrasive wheel operating at tremendous speeds to produce or aid in the production of interchangeable parts available for mass production. These abrasive wheels are often formed in intricate shapes utilizing aluminous oxide or silicon carbide, next in hardness to the diamond, and bonding these abrasive particles providing a host of sharp cutting faces, traveling at a peripheral speed of from two to three miles a minute. These precision tools with multiple cutting faces are not only used in the removal of metal to true dimensions, but are also utilized in the production of tools, jigs and dies forming a part of the mechanical assembly or forming parts one or more steps removed from the actual production parts which are needed for the assembly conveyor.

4. Furfural and its derivatives added to road building materials provide a material of remarkable tensile strength and water resistance. Thus the by-product

from farm waste can even be utilized in road building, showing the adaptability of this material for farm use.<sup>2</sup>

#### Future farm program

The future farm program calls for the concentration of furfural-yielding cellulosic materials in quantities sufficient to make furfural production economically advisable. Furfural should be produced from materials which are now available in quantities at concentration points. With greater furfural production costs will be lowered and many new uses will be available. A program of this kind will make increased revenue for the farm and indirectly the increased use of furfural will aid in the manufacture of industries' innumerable parts.

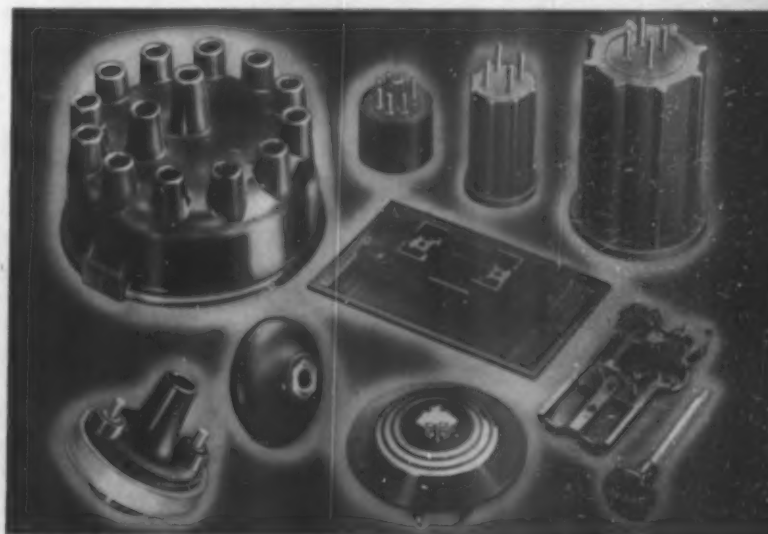
#### The chemists' aid

Furfural is classified by chemists as an aldehyde, but it is a most unusual aldehyde in several respects. The product is substantially anhydrous even in its commercial grades, it is most reactive and differs materially from other aldehydes in the diversity of products and uses into which it may enter. Furfural resinifies within itself, with certain phenols and even with certain annual growth products having phenolic (OH) groups. Furfural also reacts with and provides useful resinous products from the proteins which may also be of annual growth origin. Briefly, furfural is an excellent solvent, plasticizer, hardening agent and resin-forming reagent, providing lacquers, varnishes, impregnants, resins and molding compositions of very diverse characteristics. The production of furfural at low cost will make possible the utilization of annual growth phenolic and protein bodies, in turn rendering further income for the farmer. With furfural low enough in cost, sawdust<sup>3</sup> and other fibrous cellulosic materials may be utilized in the production of fabricated lumber of superior strength and weathering resistance.

#### Furfural-phenol resins

While furfural-phenol resins have earned a well recognized position in the synthetic (Continued on page 74)

(All photos courtesy Durite Plastics)



# LIGNIN PLASTICS

by ROBERT M. BOEHM

LIGNIN IS ONE OF THE MOST ELUSIVE MATERIALS known. It has been impossible to isolate it in an unchanged condition and this has rendered its study very difficult. Lignin varies so markedly with different species and even with the location in a single tree that classification is impossible. It is normally described by the method used in isolating it, such as alkali lignin, Willstatter lignin, and the like, and none of these are unchanged as regards the lignin in the original wood.

For purposes of convenience woody material may be roughly divided into cellulose, hemi-cellulose, lignin and extractives. The extractives vary widely in composition and quantity between trees and other sources of lignocellulose, between hardwood and conifers, between various trees of the same species and even in various parts of the same tree. An average coniferous wood

freed of extractives will contain about fifty-five percent cellulose, thirty percent lignin and fifteen percent pentosans and hexosans.

Cellulose is divided into two classes, alpha-cellulose, which is considered to be the true and undegraded type, and beta-cellulose. Hemicellulose comprises pentosans and hexosans, the latter predominating in the conifers, and the former in the hard woods and annuals.

In the manufacture of paper and cellulose derivatives, lignin is the unwanted stepchild. It is customarily removed as rapidly and painlessly as possible in an effort to secure the highest possible proportion of alpha-cellulose. In the cheaper grades of paper, a certain percentage of lignin is tolerated, but no effort is made to put it to work.

In the development of a standard product in sheet form wherein wood chips are exploded under a steam pressure of 1000 lbs. per sq. in., and the resultant fiber re-bonded under simultaneous application of high temperatures and pressures, it became apparent that the lignin played a very active part. Lignin may be considered the binding agent in natural wood, and it is always present in greatest proportions where there is the greatest demand for mechanical strength in the tree. In the study of the bond secured in this pressed wood, it was apparent that in some manner we had secured a reactivation of the bonding power of lignin and were securing the same bond, characterized by high dry strength and high wet strength, to that obtained in wood.

It was further apparent that in these manipulations, the lignin passed through a stage of definite plasticity. This plasticity was most apparent in the presence of moisture, but further study disclosed a critical range of temperature where the plasticity was greatly enhanced even in the substantial absence of moisture. This naturally led to a study of this phenomenon and it was determined that, by the heat treatment during explosion, a small proportion of the wood was converted to a distinctly plastic body. By analysis, this was found to be considerably enriched in lignin, reduced in cellulose content and containing a resinous material in very high proportions. This resinous material is absent in the original wood, but there is evidence that it has been formed from the lignin fraction by depolymerization.

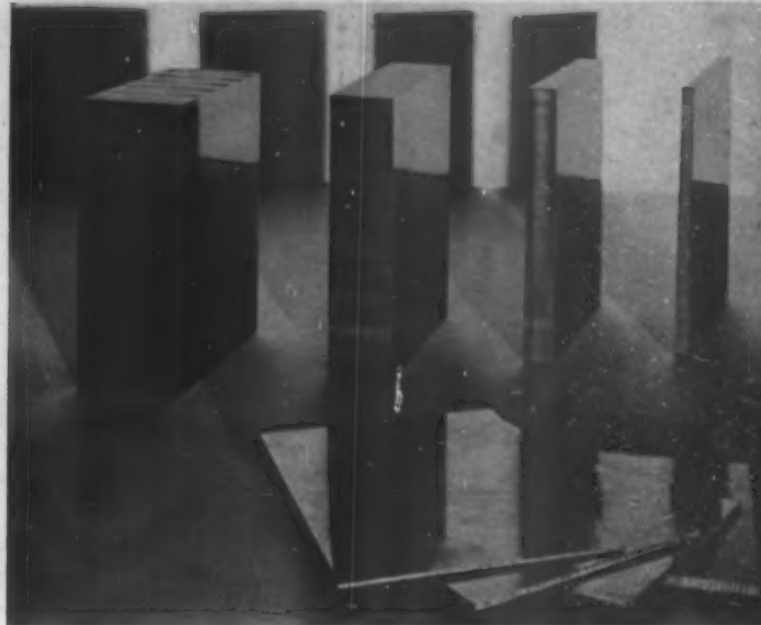
This discovery led to a long and detailed study of the effects of high temperature hydrolysis of wood. Some idea of the complications involved may be secured from the fact that the methods of analysis are largely empirical and that under these conditions, alpha-cellulose will change to beta-cellulose, to apparent lignin and to

1. Woods waste in Douglas fir logging.  
2. Sawdust pile at a Northern Wisconsin mill.  
(Photos courtesy Forest Products Laboratory)

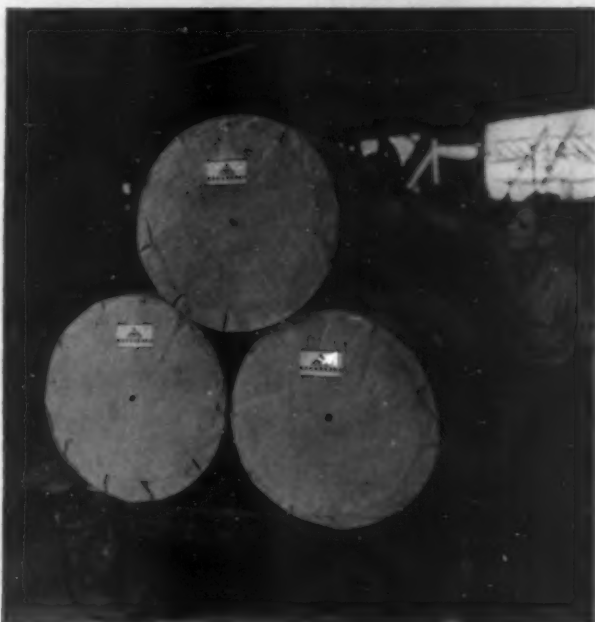




3



4



5



6

3. W. H. Mason, examining samples of both Benaloid (uncured) and Benalite (cured) all-wood plastic. 4. Transition from wood to finished plastic showing intermediate steps of chips, heat-treated fiber and uncured plastic. 5. 1000 pound rolls of the new all-wood plastic. 6. Benalite is made in thicknesses from .025 inch to 4 inches

water solubles, while the lignin will change by depolymerization and also change chemically by acid hydrolysis, the acids being formed *in situ*.

It was finally found that by carefully controlling the moisture content of the wood and the temperature and time of heat treatment above a certain critical figure, all of the wood could be converted to a predominantly plastic state which, when the water soluble end products were removed, could be molded to a homogeneous, practically amorphous plastic.

The time variable required in the heat treatment is so limited as to seem ridiculous to an industry operating

on the basis of several hundred tons a day. A variation of one second is enough to cause the difference between failure and success and one-fourth second will produce very definite changes. When it is kept in mind that this time factor is dependent on at least half a dozen other variables, some idea of the complexity of the work may be derived.

The heat treatment and explosion reduced the wood to partly fibrous and partly amorphous state. The fibrous portion enables the material to be formed on a paper machine into sheets of heavy, brown paper containing the non-fibrous portion (*Continued on page 56*)

# METHYL METHACRYLATE RESIN

by A. F. RANDOLPH

POLYMETHYL METHACRYLATE, I.E. POLYMERIZED methyl methacrylate, is one of a group of resinous bodies made by the polymerization of the various esters of alpha methacrylic acid. The chemistry of these esters, and of methyl methacrylate in particular, has already been discussed in detail in this magazine.<sup>1</sup> This group of polymerized esters includes viscous liquids such as polylauryl methacrylate, brittle solids such as polyphenyl methacrylate, tough flexible solids such as poly-n-propyl methacrylate, and rather rigid tough solids.

Of this last-named type, polymethyl methacrylate is outstandingly suitable for commercial production of plastics, not only because of its properties as a resin, but also because of the comparatively low cost and the favorable physical characteristics of the monomeric ester.

The most obvious merit of this methyl methacrylate resin is its fine appearance. A block of the cast resin a foot thick is perfectly clear and colorless. The complete absence of haze and of color make it a resin of peculiar brilliance and beauty. But while emphasis is naturally placed upon the unique clearness and freedom from color of the pure resin, it will be evident that these same characteristics make it possible for the resin to be produced in colors of infinite variety. Unlike many plastic bases which possess natural and characteristic color, usually yellowish, which must be covered up and neutralized at the expense of the purity of the resulting hue, this resin

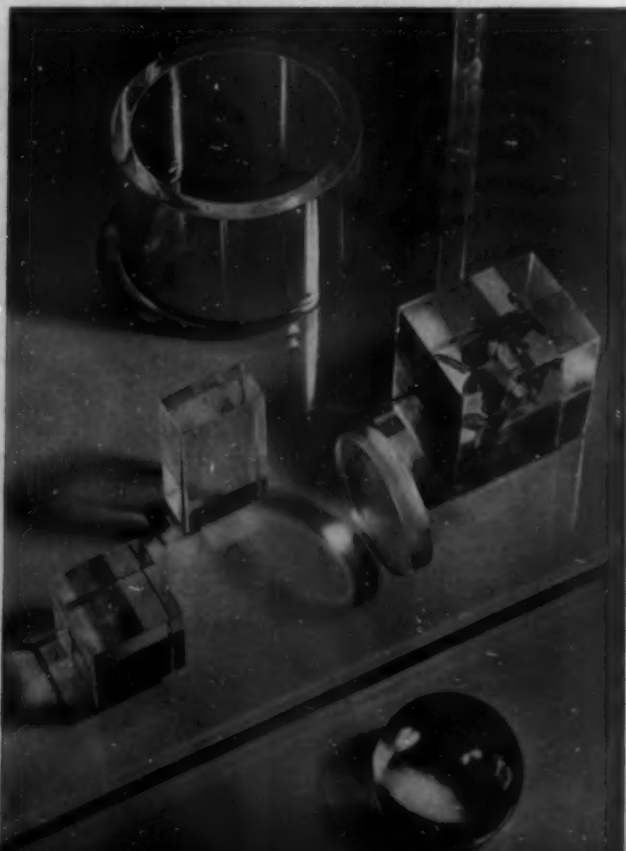
contributes no degradation of the color of dyestuffs and pigments which may be incorporated into it and the resulting colored resins are of bright pure hues. The transparent resin, whether colorless or colored, is truly transparent. Translucent and opaque forms are also available. The translucent white is particularly attractive because of its purity of tone. And rods and tubes of pearly sheen are made in various colors.

The properties of methyl methacrylate resin are tabulated in detail on the Plastics Properties Chart in this issue. Some of its more important characteristics warrant special mention.

Some of the polymerized esters of methacrylic acid are of too low a softening temperature to be generally useful as plastics, while others have softening temperatures so high as to cause real difficulties in molding. Methyl methacrylate resin, however, while having a softening temperature above those of most thermoplastic molding materials, can be compression molded at temperatures and pressures within the reasonable range available with standard equipment. For injection molding, and also in some cases for compression molding, the resin is plasticized to make it flow more readily. The unplasticized resin in cast form is not deformed by boiling water.

Methyl methacrylate resin is lighter in weight than most of the other plastics, and correspondingly yields more articles, of given dimensions, per pound. Its

Methyl methacrylate is clearer than optical glass, weighs half as much and is non-shatterable. It resists 8000 pounds pressure per sq. in., can be cut, sawed, machined, tooled, molded or cast (Photos courtesy du Pont)



specific gravity is 1.18-1.20, as compared with 1.35 for nitrocellulose plastics, about 1.30 for cellulose acetate plastics, 1.45-1.50 for urea-formaldehyde molding compounds and 1.35 for phenol-formaldehyde molding compounds with woodflour. Of the better known plastics, only polystyrene, with a specific gravity of about 1.05, is lighter in weight than this resin.

The water absorption of the resin, in either cast or molded form, is negligible under ordinary conditions. Upon immersion in water for a period of seven days the resin absorbs less than 0.5 percent of its weight of water. Because of this substantial inability to absorb moisture, articles of this resin are not subject to swelling, shrinkage or warpage with changes in atmospheric humidity. Furthermore, the processes of polymerization involved in preparing the resin in its commercial forms do not involve the use of volatile solvents, and the resin is correspondingly exempt from the shrinkage observed in some plastics as a result of the gradual evaporation of residues of volatile solvents. A fabricated article thus holds its dimensions and shape without change under ordinary conditions of service.

In shock strength, as measured by the standard impact tester, molded methyl methacrylate resin rates with molded phenol-formaldehyde of the standard type. The pure resin transmits a large proportion of ultraviolet light, and is unaffected by prolonged exposure to sunlight. If ignited, the resin burns slowly.

Methyl methacrylate resin is unaffected, at ordinary temperatures, by aqueous solutions of mineral salts, by aqueous solutions of alkalis up to about 50 percent, by concentrated hydrochloric acid or by 50 percent sulphuric acid. It is insoluble in straight-chain hydrocarbons, alcohols, ethers and the majority of fats, oils and waxes. The addition of plasticizer to the resin may in some cases slightly impair its resistance to solvents in which in its pure form it is completely insoluble. The resin is soluble in lower ketone and ester solvents and in mixtures of aromatic hydrocarbons with small amounts of alcohols.

For purposes of fabrication, the resin has the advantage of being available in both turnery shapes and molding powder, and thus permitting a selection of the most economical method of fabrication for a given article.

Being a thermoplastic material, it can be molded by the general technique already applied to cellulose acetate and other thermoplastics, and by either the compression or the injection method. For these purposes it is furnished in granular form, and in either pure or modified condition, as may be required for the job in hand. Special compositions are available for injection molding. The molding powders are regularly provided with an internal mold lubricant, so that no soaping of molds or other special precautions need be taken to ensure the release of molded articles from the molds. The molded articles reproduce the finish of the molds.

For compression molding, the material is furnished in "hard" and "soft" grades, for which the best molding temperatures, as determined by a pyrometer in contact with the surface of the mold, are ordinarily from 300 to 315 deg. F. and from 285 to 295 deg. F., respectively.



Shaping and polishing Lucite in cast form. This material may be turned on an ordinary lathe and subsequently repolished to its original luster without affecting its optical transparency

But, as in any molding work, the best temperature in a given case is ordinarily determined by actual trial.

Compression molding pressures will range from about 1500 to about 5000 pounds per square inch of projected area, depending upon the type of material used and the shape, size and depth of the mold cavity.

(Continued on page 60)

# NITROCELLULOSE

by J. M. DE BELL

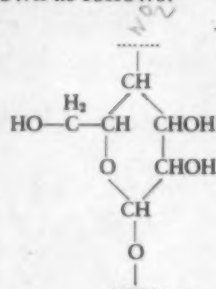
NITROCELLULOSE, THE HARDY PERENNIAL OF the plastics industry, experienced another eminently successful year in 1936, attaining production rates which surpassed the peak years of 1928 and 1929. It is estimated that 60,000,000 pounds of nitrocellulose were produced,<sup>1</sup> (exclusive of explosives) of which 20 percent were used in plastics; and the competition of the newer synthetic resins and other cellulose derivatives have served not so much to diminish the use of nitrocellulose as to increase the public interest in all thermoplastics.

Commercial utilization of an enormous quantity of sheets, rods and tubes has been previously published in MODERN PLASTICS;<sup>7</sup> so that rather than duplicate this enumeration, this present article will deal with the historical and technical development of the product, together with industrial trends which are becoming more pronounced at the time of writing.

## Nitrocellulose for plastics

Nitrocellulose itself, although available in the middle of the preceding century, was much delayed in industrial

applications on account of the lack of understanding of the chemistry of cellulose and the difficulty of nitrating under such conditions that the resulting product could be purified and achieve sufficient stability. These handicaps, however, have long since been definitely overcome. From the chemical angle, Meyer & Mark<sup>2</sup> have shown that for chemical consideration the cellulose molecule can be considered an agglomeration of glucose residues of the structure shown as follows.



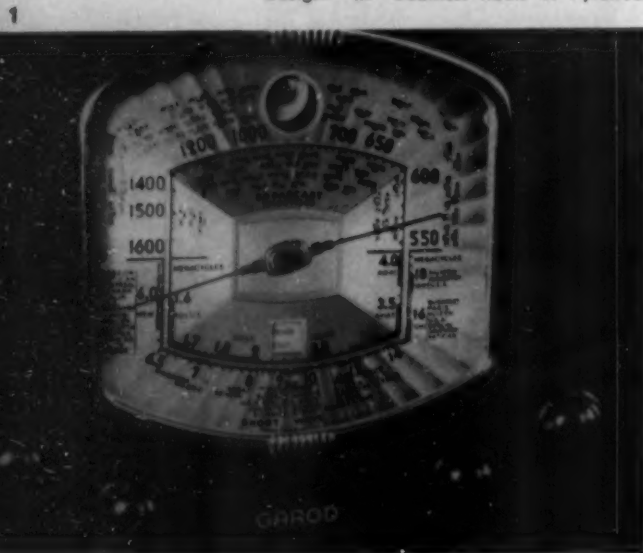
It, therefore, behaves like a clumsy trihydric alcohol; and the three hydroxyls are capable of the usual chemical transformation of this radical, although the complexity of the molecule makes reaction much more difficult than in the case of simpler homologues. The glucose residues are strung together into much larger molecules; and the bigger these are, the higher the viscosity, shown below.

When cellulose is treated with a mixture of nitric and sulphuric acids, nitration occurs on these alcoholic groups. Complete substitution to a tri-nitrate would give a product containing 14.16 percent nitrogen, but in practice the average hydroxyl substitution is only slightly over 2. Nitrocellulose for various uses has substitutions about as follows:

|                  | PERCENT N | HYDROXYL<br>SUBSTITUTED |
|------------------|-----------|-------------------------|
| Guncotton        | 13.2      | 2.7                     |
| Smokeless powder | 12.5      | 2.5                     |
| Lacquer          | 12        | 2.2                     |
| Plastic          | 11        | 2.0                     |

It is interesting to observe (and apparently holds for the bulk of cellulose derivatives, both esters and ethers) that as the substitution increases the softening point of the product under heat decreases until a substitution between 2.0 and 2.4 is reached. Thereafter, the softening point increases to the tri-substitution stage. Best plastic behavior is obtained at that substitution where the softening point under heat is low: in fact, most tri-substituted cellulose derivatives have no plastic properties at all although they can be deposited as film from solution in suitable solvents.

1. Celluloid dial with metallic machine design. 2. Scuffless heels of Pyraheel

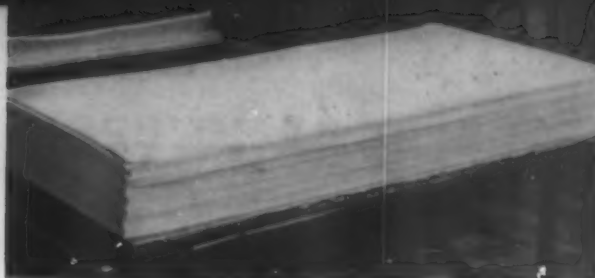


## Pyroxylin plastic

Pyroxylin or nitrocellulose plastics date back to days when technical control was utterly absent and progress was made solely by cut and try experimentation. Therefore, it is not surprising that it was over ten years after the discovery of nitrocellulose before A. Parkes<sup>3</sup> proposed a crude type of plastic from nitrocellulose oils, camphor and copious draughts of solvent (1855-1866). Commercial application, however, dates from the work of the Hyatt Bros. in 1865-1869, and their discovery of the latent solvent powers of camphor for nitrocellulose, together with methods of working, which eliminated the bulk of the objectionable solvents. They realized for the first time that the great factors in the handling of thermoplastics are heat and pressure—and this in spite of the extreme heat sensibility of the product with which they were dealing. Their essential processes are the basis of the pyroxylin colloid industry of today. This consists in reducing nitrocellulose to a good plastic working condition by first colloidizing in heavy masticating mixers alcohol wet nitrocellulose, camphor, small amounts of modifying agents and solvents. When the mass is thoroughly colloidized, it is filtered under high hydraulic pressure and then worked on slightly warm rolls until much of the solvent has been driven off. This also serves to complete colloidizing, and at the same time coloring materials can be worked into the sheet. After rolling, the materials are baked for several hours at a warm temperature, in cakes which may weigh as much as five hundred pounds. The standard size of cake and sheet in the nitrocellulose plastic industry finishes to 20 in. by 50 inches. This baking operation not only serves to compact the plastic into a homogeneous mass, with comparatively low solvent content, but it also eliminates bubbles. Following the baking operation, the plastic is placed on a sheeter which slices off sheets of any desired thickness. These still have enough solvent content so that it is necessary to season them for a period of a few days to several months, depending on the thickness of the sheet.

Whereas other cellulose plastics lend themselves to forming with much less solvent and much higher temperatures, the very fact that nitrocellulose undergoes such a protracted treatment, also encourages the production of the multi-colored and infinite designs which make this plastic so attractive to the eye. Innumerable combinations, imitations of other materials, pearl effects and the like, are obtained by taking different colored sheets, laying them up in various ways, re-baking and re-sheeting: this accounts for the tremendous leadership which nitrocellulose plastics have achieved in decorative fields such as tooth-brushes, fountain pens, toilet sets, wood heel covering, spectacles, pocket cutlery and similar articles.

It goes without saying that when the material is in the plastic condition, it can be handled not only as sheets, but can also be extruded from tubing machines to give rods and tubes which undergo analogous treatments. For toughness, available colors, available de-



3. Slabs of nitrocellulose as they leave rolls.  
4. Nitrocellulose being discharged from masticator. (Photos courtesy Fiberloid Corp.)

signs, water resistance and low costs, these materials are still outstanding. Wider application, will always be hampered by light instability and flammability.

## Lacquers and protective coats

To this writer, plastics and the protective coat field are separated by practically nothing but a distinction in thickness. While it is true that plastic properties are not essential in most protective coats, nevertheless almost the same nitrocellulose appears in lacquers and has been responsible for some of the most interesting developments in the chemical field. It was early recognized that nitrocellulose formed an admirable protective film but the high viscosity of its solutions forced a low solids content and, therefore, its use was distinctly uneconomical. Viscosity is merely a matter of molecule size, so as soon as technicians were successful in breaking down the big molecules to little molecules, without changing the chemical structure units, the use of nitrocellulose in lacquers eliminated the older oil varnishes and enamels in many fields, notably motor cars. The reduction of viscosity can be effected in various ways, but the principal ones are by digestion at high temperature and pressure, or by the use of cellulose which has itself been degraded before nitration. While low viscosity nitrocellulose solutions had been prepared for some time back, the du Pont Company was the first to make real industrial utilization of (Continued on page 120)

# PHENOLIC RESIN PROGRESS

by H. S. SPENCER

TO THE UNFAMILIAR, STEEL IS STEEL. TO THE manufacturer using steel, there are so many grades that his stock room has a color code system of marking each incoming lot for identification. For the steel men learned long ago much of alloys, and so today steel is made to meet specific conditions, as resistance to corrosion, electrolysis, rust, wear, abrasion, etc.

The same research and refinement that metallurgists had brought to the steel mill, chemists have been accomplishing with phenolic resins, generally classified as resinoids. Broadly, resinoids are divided into major groups, as molding compounds, clear or transparent materials, laminated sheets, rods and tubes, heat-hardening liquid products, varnish lacquer and adhesives.

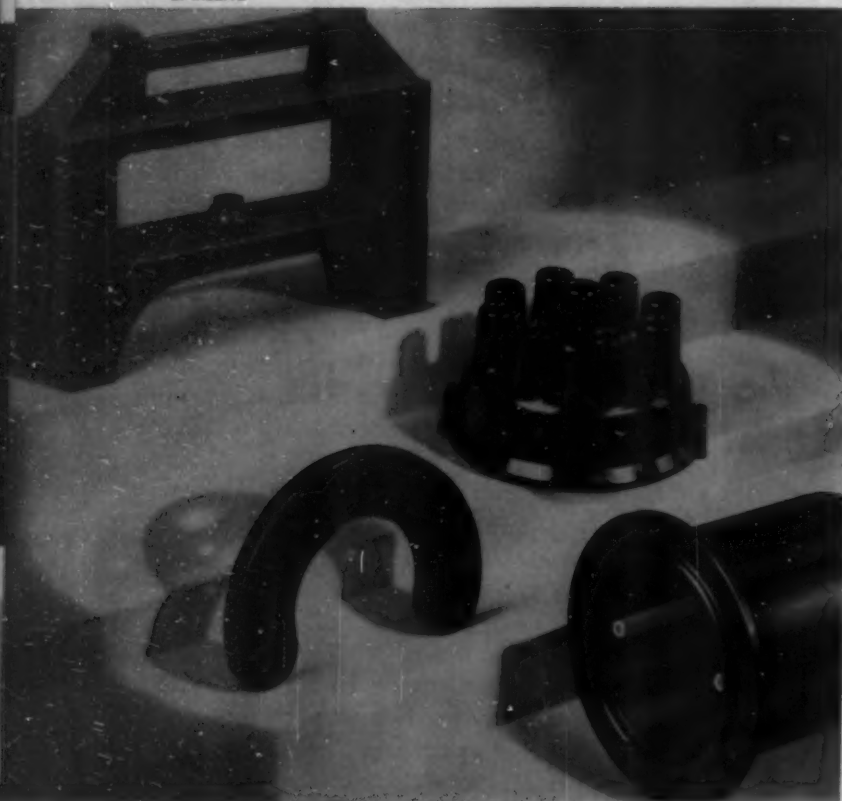
These thermosetting plastics have made many advances, but no single phenomenal development has been recently announced. Rather, the entire range of phenolic resin products has been extended and improved. Their scope has been enlarged. They more adequately meet the various conditions that confront them and thus make their adoption possible to many new fields.

More and more in the manufacture of molding compounds has the industry moved away from a single material or a few materials, and today there are numerous variations and new materials created as a result of more extensive use and to meet new conditions. And so industry has acknowledged phenolic molding compound as a structural material ranking with metal, ceramics, rubber and wood, warranting the consideration of engineers. For the materials possess inherent advantages and limitations, sufficiently distinct that they can stand alone, not as substitutes but as new and additional materials having a technical personality all their own, with an assortment of properties of varied and broad adaptability.

Recent refinements have been developed with almost daily regularity by the extensive research staffs maintained by the larger manufacturers, as in the elimination of the fogging of film in the manufacture of cameras, resistance to water and deterioration through constant submersion in the manufacture of flush valve parts, resistance to abrasion, and so on through a list of widely assorted problems of product applications as they are met.

Left: A typical low-loss application of four types of phenolic molded; radio capacitor frame, automotive distributor head, motor contact strip and frequency meter housing. Right: To prevent corrosion, Johnson outboard motors have phenolic ignition parts molded by Eclipse Molded Products

BAKELITE



DUREZ





1



2



3

Among the recent advancements in molding compound manufacture is the announcement made several months ago by one manufacturer, of an extra-strength material, the impact strength of which is about five times that of standard material. Also, there is the improvement of preforming qualities of this class of material. (Pre-forming or briquetting in molding speeds production and the handling of material.)

The necessity more adequately to meet the requirements of high frequency radio and electrical equipment called for improvement, and a special dielectric material was developed which cuts high frequency electrical losses. Another newly-found means of securing strength in certain parts exposed to severe impact or flexing, was the adoption of resin boards. These partly cured phenolic sheets when used in combination with ordinary molding compounds produced stronger parts than would the compound by itself.

Certain types of moldings need "jumping" off of the molded piece to permit rapid removal from the mold, as with small protruding parts or the track in threaded pieces, forcing or "jumping" off is faster than disassembling the steel mold or turning the piece out through the threads. To meet this requirement a material of great plasticity which would harden and complete its function after removal from the mold was necessary. It required study and the development of a material of great elasticity for such applications. Another slight variation of the same problem of elasticity, but for a totally different purpose, was in the manufacture of automotive bumper shoes. Elasticity in the compound produced a better material to meet the bumping or abrasive condition set up through the friction occasioned by the opening and shutting of doors over a long period of time, the resiliency of the material absorbing a proportion of the shock.

A lower specific gravity than in normal materials permits more parts per pound of material used, providing a satisfactory material for certain limited uses. Another refinement was the elimination of bleeding or running of the color in finished parts where they came in contact with liquids, particularly as in the bottling of beverages where molded caps were used on containers. Again, compounds were improved so as to give faster cure, the increased use of automatic presses requiring it. The material manufacturer produced such a compound. Also



4

1. Interoffice communicating unit has a Durez cabinet molded by Remler Co. 2. Electrically operated Zero Hour Bomb Co.'s bomb is a time controlled detonator for exploding charges of nitroglycerin. Grey Bakelite encases the ignition system molded by Ingersen Mfg. Co. 3. Man-size advertising ash tray molded of Makalot. 4. Rough-service cable connectors, heavy-duty toggle switch handle and fire extinguisher cones molded from medium high impact material

there has been a marked improvement in the manufacture of materials using asbestos fillers, so that the difficulty in molding these caused through sticking in the press has been eliminated. Materials are being produced today with a richer, higher luster and a more uniform texture in the appearance of the finished piece. Thus many refinements have been made and an extended line of more diversified materials is made available.

The manufacturer of resinoids must also be credited for his ability to keep pace with the rising prices of raw materials and the upward trend in the compensation of labor, as well as the additional burden of increased taxation. Yet improved manufacturing methods, by comparison with 1932 as an example, permit turning out a 100 percent increase of material in less factory space with equivalent but improved equipment over that of five years ago, and thus these manufacturers have been able to maintain the same sale price for their compounds.

Manufacturers of phenolic plastics have fully realized

the shortcomings of their products and that the existing characteristics of their materials must be improved. They have worked to improve color, weight and strength, and real progress has been made, considerable of it within the past year. They have not hesitated to spend large sums of money to perfect their products, because they have always seen a very large ultimate market for phenolic compounds.

Molders of these materials, as well as machinery manufacturers have endeavored to keep pace. The spirit of the industry was well expressed by B. F. Conner, Manager of the Molding Division of Colt's Patent Fire Arms Mfg. Company, speaking before the American Society of Mechanical Engineers: "We know that these answers cannot evade us for long. We are convinced now that the answers are within our grasp and we assure you that these commoners of the plastics group will do their share of the steering on that road that leads direct to our coming Plastics Age."

As industrialists have come to recognize phenolic molding compounds and plastics generally as structural materials, they too have found that there are many problems that these materials alone have been able to solve. Nothing heretofore tried has proved as successful as phenolic materials for thread guides, rollers and other

parts in the manufacture of silk thread and rayon, because they are not affected by the acid baths used, do not discolor nor wear out, can be held to the fine accuracy required of such parts. They have been found superior in commutator parts, hair wave appliances. Nothing was ever found as satisfactory for radio tube bases both from a production angle and the elimination of noise in the tubes. Buttons made of other materials do not withstand the dry cleaning process and pressing with hot irons as do these materials. Years ago they solved the problem of automobile distributor heads.

Phenolic resins brought to the electrical industry the practicability of molding in metal inserts and molding over metal, securing greater dielectric strength, elimination of corrosion, high thermal resistance, higher resistance to the effects of sea air, acids, fumes and oil, elimination of painting.

The advancement in the manufacture of phenolic plastics has in turn reacted in their broader acceptance by industry, and progress was made in the use of plastics during the year in airplane applications. The United Air Liner line's instruments are very nearly all now made of phenolic resinoids, replacing metal because of their lighter weight and greater functional advantages. These are different from many of the (Continued on page 102)

Housings for telephone, vacuum cleaner and sewing machine treadle made from improved impact molded phenolic

BAKELITE



# PHENOLIC-ASBESTOS FOR INDUSTRIAL EQUIPMENT

by WILLIAM H. ADAMS, JR.

IT IS NOW ALMOST FIVE YEARS SINCE THE introduction into the United States of the molded phenolic resin product known as Haveg. The nature of the material, and its application to large scale corrosion resistant equipment in the chemical industry, has become, during this time, so well known that a detailed description is hardly necessary. What Haveg is, and what it does, has been rather thoroughly covered in earlier articles in various publications.<sup>1</sup> It is the intention of this discussion to describe certain of the more recent developments and applications of this material, and to point to trends in design.

Very briefly, it is a molded material consisting of a mixture of a specially acid washed asbestos and a phenol-formaldehyde resin, which was originally developed in Germany in 1922. This composition gives strength and durability, together with a very good resistance to corrosion, particularly acid corrosion. The process by which it is molded is unique, in that light inexpensive molds can be utilized. As a result, mold costs become negligible even on very large equipment. The material has been built in the form of tanks and other large size apparatus in dimensions running up to 9 ft. or even greater.

The earlier applications of this material in this country, which roughly paralleled the experience in Germany, were very largely in the chemical and textile fields. In both these fields, the major problem was the production of cylindrical and rectangular tanks, a few simple types of towers, vats and similar articles, which would have resistance to corrosive chemicals and acids. Not long after the development had been started in the United States, a series of new problems began to be evident. These problems developed from the fact that the requirements of American industry were for larger size and more complicated equipment than had previously been experienced.

One of the earliest problems, yet one of the most difficult to solve, proved to be the question of standardization of sizes. In the manufacture of cylindrical and rectangular tanks, we early discovered that practically no two customers would require identical sizes. Now, while mold expense in the process is small, it is none the less a factor when only a single unit of a given size is required. The result was that the price of these items was rather higher than the inherent process warranted.

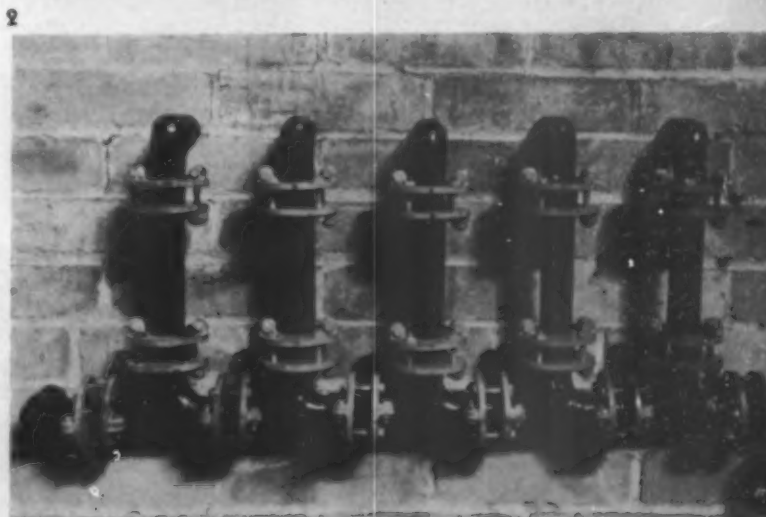
On cylindrical tanks, this problem was met by providing a series of standard molds from 12 in. in diameter up to 9 ft. in diameter. It was found that practically any depth of tank could be produced in these same molds with little or no change. It then became possible to

standardize on diameters, and since a sufficient number of standard sizes were selected, the standardization proved successful. We now almost never receive a call for non-standard diameters in cylindrical tanks. As a result, mold amortization figures have become almost non-existent and very reasonable prices now apply.

On rectangular tanks, the problem was more complex. Since variation might be called for in the length, width or depth—any one, or all three at the same time—an almost infinite number of sizes were possible. This problem was finally also solved by standardization.

Molds of an interchangeable nature were provided, built in 6 in. steps, making it (Continued on page 118)

1. Haveg pickling tank, standard design, about 10 ft. by 3 ft. by 3 ft. deep. 2. Installation of pipe and fittings showing method of connection



<sup>1</sup> See bibliography at end of article.

# RUBBER-LIKE RESINS

by DR. J. C. PATRICK

NOT LONG AGO THE PAPERS CARRIED THE story that Hitler had increased the import duty on rubber by almost 100 percent in order to spur German industrialists to even greater efforts in making and using synthetic rubber. A little while back, the Soviet Government peremptorily announced that 50 percent of the entire Russian Vodka output would be earmarked by the State for use in the manufacture of synthetic rubber. By and large it is safe to say that practically every major European power, with the exception of Great Britain and Holland, is today making a private, determined effort to establish within its borders production of synthetic rubber to equal the rubber demands of the country.

In this country, the interest in and the application of rubber-like resins have been no less wide. However, whereas in Europe wholesale adoption is being predicated upon national economic self-sufficiency, in America a more balanced progress in the use of rubber-like resins has come about through the careful evalua-

tion of available types. And it may be said that the developments that have taken place here during the past few years in the application of these materials have indeed been impressive.

## Origin and types

The history of the efforts of chemists to synthesize rubber began at least as far back as 1879. At that time G. Bouchardat definitely recognized isoprene as the parent hydrocarbon of rubber and demonstrated that the isoprene obtained from the destructive distillation of natural rubber could undergo polymerization to re-form a rubber-like solid.

Manufacturers of rubber-like resins in both Germany and Russia are now producing butadiene rubbers (in Germany it is reported that about sixty tons a month are now available, although some estimators put the figure at one hundred and fifty tons). The interest in butadiene rubber received its first great impetus shortly after the World War due to the closely controlled supply of natural rubber and the fact that the cutting off of this supply to the Central Powers during the war had brought home keenly the fact that the properties of rubber make it indispensable. During the war about 2,500 tons of synthetic rubber were actually produced in Germany, but the quality was far from good. After the war, intensive research was carried on with the object of duplicating natural rubber, that being then considered the goal (i. e., in the light of Bouchardat's discovery).

Practically all the work was therefore done on the butadienes and a close study was made of methods of polymerization. But it was not, however, until Mathews in England, and Harries in Germany, discovered the great superiority of a metallic sodium catalyst that the production of the butadiene rubbers appeared practical.

The properties of the butadiene rubbers are not as yet satisfactory. They are much more resistant to paraffins than natural rubber, but the high price and difficulties of processing make it improbable that they can compete in an unregulated market with the natural product which they so closely resemble. For this reason, the writer believes they will never attain commercial importance in America.

Two rubber-like resins chiefly share the interest of Americans. One is a polymer of chloro-butadiene (2-chloro-1-3-butadiene) and is being widely applied in the United States. It shares with the straight butadiene polymers greatly improved resistance over natural rubber to lubricating oils and gasolines, but represents a distinct improvement over them in that it is processed without much difficulty. Like (Continued on page 80)

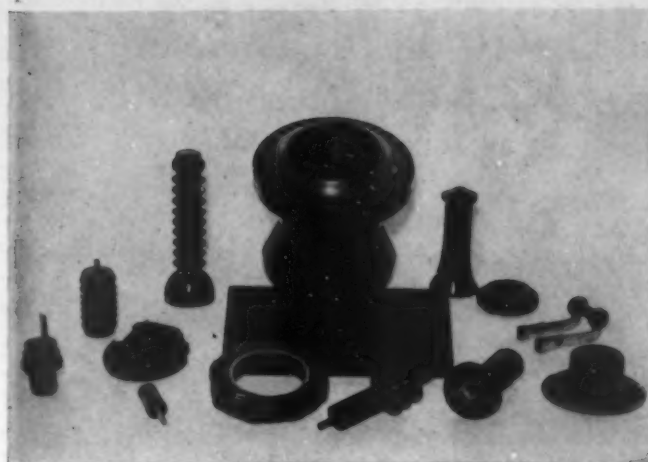
1. Milling rubber-like resin to expel all water and liquid chemicals from it. The material pictured is termed "synthetic rubber crude."
2. Impregnating these gloves with rubber-like resins increased their usefulness for workers in oil refineries (All photos courtesy Thiokol Corp.)

1



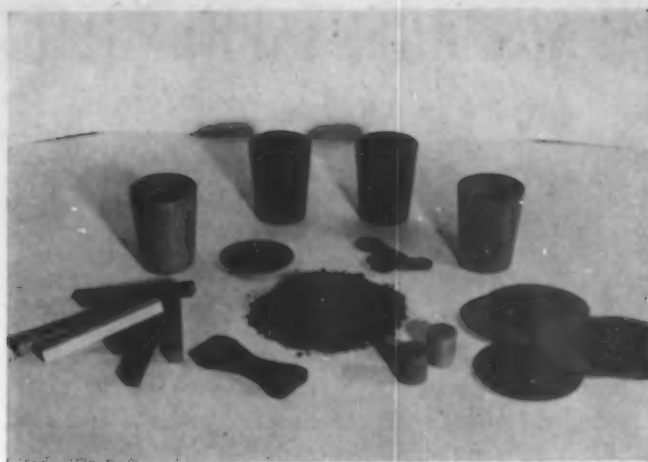
2





1

1. From the collection of shellac moldings the Indian Government is assembling



2

2. Experimental moldings at Polytechnic Institute made from shellac molding powders

## SHELLAC: A GROWING FACTOR IN INDUSTRY

by DR. WM. HOWLETT GARDNER

SHELLAC LEADS ALL OTHER RESINS IN THE variety of uses for which it has been employed, and the diversity of other raw materials with which it has been combined. Besides the demand for shellac as a very fine varnish, the plastics industries in one form or another have always been numbered among the large consumers of this product, and in the last year its usefulness has increased in these and in other industrial fields.

The relatively low price level which has persisted for shellac recently in contrast to the rise in price of some other raw materials has unquestionably contributed its part to the increased consumption and interest which exists in shellac at the present time. However, it is interesting to note in this connection that higher standards are being demanded by industries even at a slight price differential over older grades. The newer native grades of shellac which are practically free from orpiment and are low in insoluble matter are proving very popular. These grades were recently adopted by the United States Shellac Importers Association as a set of special standards. New specifications issued by various industries demanded cleaner lac of a definite fluidity when melted.

### Shellac in the field of plastics

It has always been very difficult in the absence of any accurate engineering survey to estimate what portion of the lac imported is actually used as a plastic resin. Many concerns such as those in the phonograph industry have employed it both as a plastic and as a finish in the manufacture of their products. It is impossible therefore to classify or to differentiate its uses from available

sales figures. We can, however, determine certain trends from specific increases in purchases and from the increased output of certain manufactured articles such as has taken place during the last few months. These trends certainly indicate a marked increase in the quantity of shellac used in the plastic industries at present.

The increased consumption of shellac in the phonograph industry has been truly phenomenal. It has even been predicted that more than 30,000,000 records will be sold during 1937. This is seven times the number sold in 1932 and more than half the records manufactured per annum during the years 1915-1917, the peak years of record consumption, when it was estimated that from one-third to a half of the shellac imports were sold to phonograph manufacturers. It is also estimated that the larger part of this year's business will be in records of classical music, which in part might explain the sudden increase in number of records sold, and would suggest that the public at large has again become interested in selecting their own programs for home entertainment. Certainly it is far in excess of any estimate which could be based alone upon the upward trend of business at the present time. The popularity of the radio injured the phonograph production in this country, but this never occurred abroad.<sup>1</sup>

The placing of contracts for large generators and other pieces of electrical equipment has also created an increased demand for shellac in the plastic field. Here large quantities of shellac are used in the manufacture of laminated paper insulators and in mica insulation products. Shellac is used both as (Continued on page 116)

# TRANSPARENT PHENOLIC MOLDING MATERIALS

by DON MASSON

EVER SINCE PHENOLIC PLASTICS WERE FIRST introduced there has been a demand for a transparent thermosetting phenolic molding material which could be molded in the conventional compression molds. In the early days of the industry materials of this type were developed, but their limitations, as compared with regular opaque molding materials made with fillers, were so great that they did not prove commercially successful. For instance, these materials were extremely difficult to mold and upon exposure to light they would darken considerably.

Through continued research, several types of transparent phenolic molding materials have been developed. Many of the limitations and disadvantages of the older materials have been overcome. Molded parts produced from these materials are extremely attractive due to their rich depth of color and transparency.

There are so many varieties of plastic materials on the market today that the first questions one asks are, "Why, transparent or all-resin types of phenolic molding materials?" and "What properties do they have to justify their existence?" Following are a few of their unique and peculiar characteristics:

## Properties

### 1. Heat resistance

Since the material is thermosetting, the molded parts do not soften or warp when subjected to heat. Parts have withstood temperatures up to 225 deg. F. over long periods of time with no particular ill effects. On short time test, parts have been subjected on some types to 300 deg. F. with no ill effects. This heat resistant property is probably the greatest of all the advantages that this class of materials offers.

### 2. Hardness

The hardness of these materials can be varied over a wide range, depending upon the types. This property is exceedingly interesting when the material is considered for the following applications: traffic signal lights, tail light lenses in automobiles and any use where dust or other abrasive material is likely to come in contact with the product in use.

### 3. Dielectric strength

In general, these materials possess excellent dielectric properties, exceeded only by the styrols and polystyrols.

1 and 2. Cosmetic jars produced in tortoise shell and ruby red transparent phenolic molding material. 3. Transparent amber instrument housings

BAKELITE 3





4



5



6



7

BAKELITE

4. Jigger cap molded by Terkelsen. 5. Ruby red furniture drawer pull molded from transparent phenolic. 6. Electric push button hoist control with transparent molded housing employed as a sales demonstrator. 7. Transparent refrigerator handle

Power factor, dielectric constant and hence power loss factor, are better on these materials than on any other class of transparent plastic molding materials except for the two just mentioned.

#### 4. Moldability

These materials may be molded in regular production molds which have been used for producing general-purpose opaque phenolic materials, with few exceptions.

#### 5. Flammability

While these materials will support combustion, they are relatively non-flammable.

The following properties, which other plastic materials possess to a greater or lesser degree, are also of interest in considering these new transparent phenolic molding materials.

#### 6. Dimensional stability and retention of definition

Since these materials polymerize (thermoset) when molded, they possess, to a marked degree, the same character of dimensional stability and retention of definition that is maintained by parts produced of general-purpose, cellulose-filled phenolic molding materials.

#### 7. Lightness in weight

In general, they are about 7 percent lighter than general-purpose, cellulose-filled phenolic molding materials.

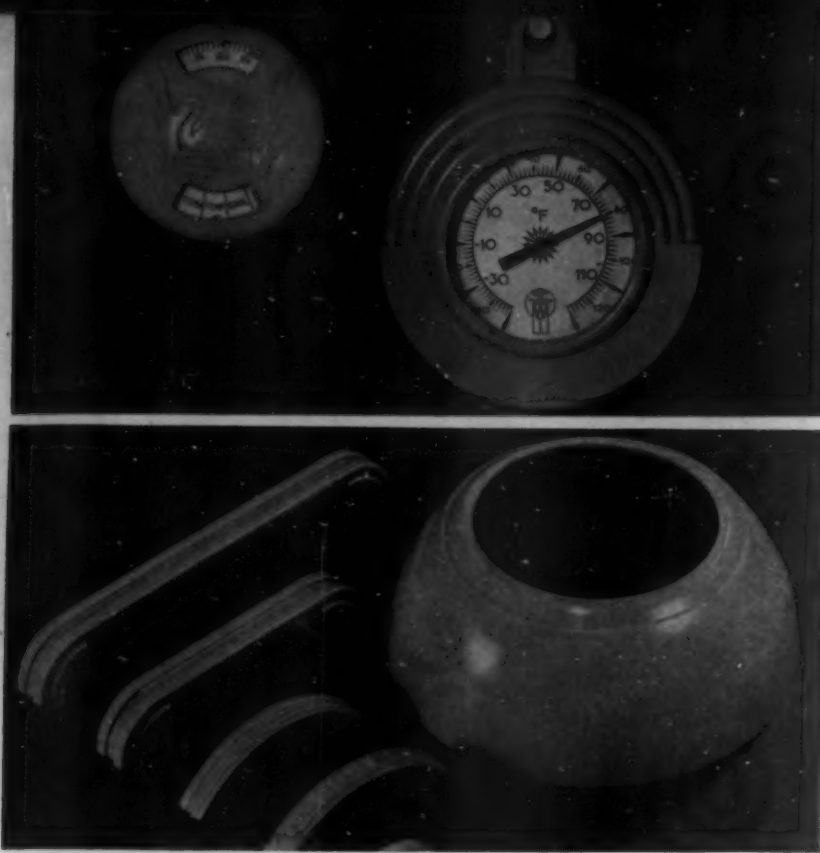
#### 8. Chemical resistance

In general, they are extremely non-hygroscopic. One class approaches glass in freedom from odor.

In order to give some indication of the properties that are obtainable, the following tabulation furnishes approximate average values:

| Physical Properties*                                  | Transparent<br>M/M                   | Standard Cellu-<br>lose-Filled<br>Molding Mtl. |
|---|--------------------------------------|--|
| Shrinkage   | 0.011" per in.                       | 0.0075" per in.                                |
| Specific Gravity                                      | 1.27                                 | 1.36   |
| Tensile Strength                                      | 8,000 lbs. per sq.<br>in.            | 7,000 lbs. per sq.<br>in.                      |
| Impact Strength (energy to<br>break)                  | .20 ft. lbs.                         | 0.15 ft. lbs.                                  |
| Flexural Strength                                     | 16,000 lbs. per sq.<br>in.           | 10,000 lbs. per sq.<br>in.                     |
| Chemical Properties                                   |                                      |  |
| Water Absorption (cold) disk<br>4 1/4 x 1/8 — 48 hrs. | 0.15%                                | 0.60%  |
| Electrical Properties                                 |                                      |  |
| Power Factor—   |                                      |  |
| 60 cycles per sec.                                    | .06                                  | .30  |
| 1,000 cycles per sec.                                 | .04                                  | .13  |
| 1,000,000 cycles per sec.                             | .019                                 | .05  |
| Volume Resistivity                                    | 7.5 x 10 <sup>6</sup><br>megohm cms. | 1.7 x 10 <sup>8</sup><br>megohms cms.          |
| Dielectric Strength (step<br>method)                  | 325 volts per mil.                   | 350 volts per mil.                             |
| Dielectric Constant                                   |                                      |  |
| 60 cycles per sec.                                    | 5.5                                  | 11   |
| 1,000 cycles per sec.                                 | 5.0                                  | 7  |
| 1,000,000 cycles per sec.                             | 4.5                                  | 5.5  |

\* Note: The data given in this table were determined by A.S.T.M. (or standard) tests of Bakelite BM-9131, using A.S.T.M. (or standard) specimens. It cannot be assumed that pieces of a variety of shapes, molded under a variety of conditions, would, on test, possess the absolutely identical properties given. (Continued on page 64)



The diversity in applications of urea resins is illustrated by this light reflector and two thermometers of Beetle and the reflector and refrigerator handles at lower right which are of Plaskon. Translucence and brilliant color are characteristic of ureas

## UREA RESINS AND MOLDING COMPOUNDS

by W. H. MacHALE

IN ORDER TO APPRECIATE THE EFFECT UREA-formaldehyde resins and molding materials have had on industry in general over the past year, it is necessary to examine certain of the unique properties inherent in these materials. It would be extremely difficult to point out any commercial use of this type plastic today without at the same time enumerating one or more of its properties as a reason for such use. Still further, any attempt to limit the broad outlines of future applications would be difficult because of the ready applicability of the fundamental resin to so many industrial uses. It may be readily seen from the following discussion in which properties are treated as reasons for use, that the application of urea-formaldehyde materials is still in its infancy and only the frame of the picture has been made.

Urea resins and molding materials were introduced in this country but a few years ago. As new products, several of their novelty characteristics were exploited. Molded tableware and premiums formed the bulk of the business. Although at that time industry was retrenching and was not enthusiastic to undertake new and fundamental developments, urea products slowly

began to gain recognition as practical and useful materials. With improved business conditions, especially during the past twelve months, urea materials have made such progress that the present producing units are taxed to capacity.

In discussing urea materials, we should like to distinguish between urea resins and urea molding materials. Urea-formaldehyde resin is the base of all urea products, and in combination with a ground cellulose filler, it becomes urea molding material. Urea molding materials constitute the largest use of the resin, and are the most widely known and used form of the product on the basis of markets.

Urea-formaldehyde resin is a colorless liquid which is fusible and partially soluble. This resin when subjected to temperatures of approximately 275 deg F. to 315 deg. F. undergoes a rapid chemical change which renders it insoluble, infusible, odorless, tasteless and generally chemically inert. The colors available in combination with the resin, or in combination with resin and filler as a molding powder, are unlimited, and constitute an integral part of the material. Color brilliancy, stability

and purity are qualities inherent in the material and are limited only by the limitations of certain dyes or pigments. Because of active and successful research along these lines, the number of unstable colors is rapidly approaching zero.

Urea resins are supplied in various forms for many and diversified applications. For example, urea resins in solution are used for the impregnation or coating of paper and fabrics, and in the formation of lacquers and enamels. Layers of paper, impregnated with the resin, when subjected to the combined action of heat and pressure, are formed into homogeneous laminated panels, in all desirable colors.

Urea resins in solution are also used to serve as a stiffening agent for fabrics, or to render them creaseproof. Urea resin is used in compounding cold setting cements, which produce a tough, durable, water resistant and odorless bond.

Let us examine therefore what uses have been made of these unique properties over the past year. Our discussion will deal first with the molded form of the product. We can assume that our readers understand that this form of the material is supplied as a powder or granule, and is molded in the same dies and in much the same manner as are phenolic molding materials.

The two markets or uses for urea molding materials which have shown the greatest development over the past twelve months are housings, such as radio cabinets, clock cases and instrument cases—and lighting applications. The material's use for housings and cabinets was a natural result of certain inherent qualities in the product which offered manufacturers an excellent solution to certain of their sales problems. The radio industry, for example, has been competing for years on the basis of mechanical perfection, and had reached a point where competition was resolving itself into varia-

tions of cabinet design. The urea material offered color, unlimited and permanent colors which were not a surface characteristic, but part of the material itself. This color sold radios, clocks and thermometers, not only by virtue of its greater display value in the retail outlet, but because of greater consumer recognition and appreciation of color in the modern home.

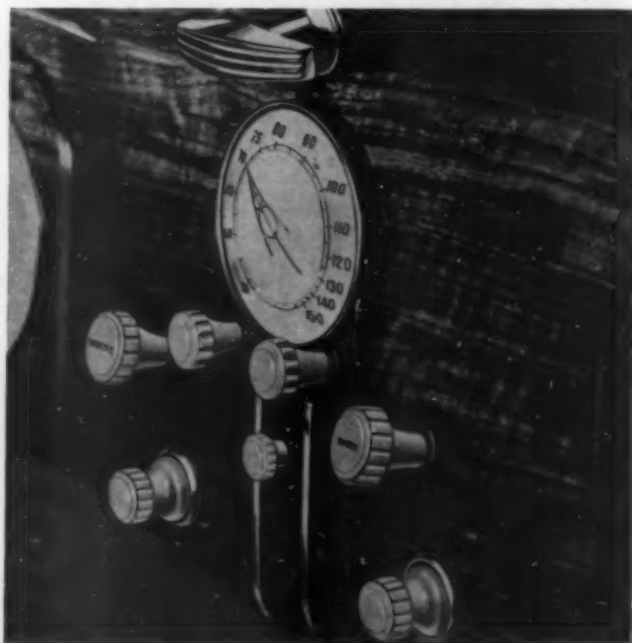
Radio manufacturers, recognizing the value inherent in the use of plastic cases, are now using or are building molds for some twenty-odd different type cabinets, ranging in size from the tiny three piece Emerson cabinet to the huge Pilot case, one of the largest one piece housings produced to date in this country. Naturally all production from these molds is not urea, but one representative molder claims that urea demands are averaging approximately seventy percent of the total pieces produced.

The housings for electric clocks, scales and timing devices offer considerable economies to the manufacturer in the matter of weight saving. Outstanding as an example of this point is the Toledo Scale housing, which is said to weigh seventy percent less than its metal counterpart, thereby affording savings in the way of shipping and handling costs.

Not only are weight saving and color factors of importance to the manufacturer, the problem of assembly of the complete product is much more simple. There is no danger of chipped paint or veneer, or scratched surfaces on the assembly line. The housing is molded into a complete product, ready for mounting.

In view of the compound's natural adaptability to such uses as housings, it is believed essential that designers of such parts should familiarize themselves completely with the properties and methods of molding urea products. Plastics, as a whole, are new products, and certain members of the group do not suffer from the limitations of natural materials formerly used for such

Illuminated dial on Ford's V-8 is molded of translucent non-glare Plaskon



Traveling case by Harriet Hubbard Ayer is fitted with molded Plaskon cosmetic jars





Helena Rubenstein created this compact make-up kit which is molded of Beetle by Colt's Patent Fire Arms Co.

applications. The designer should recognize that urea molding compounds *are molded*, and as a result parts should be designed in such a way as to facilitate the most satisfactory flow and cure of the material in the mold. Designs should be so constructed as to permit even flow from thick section to thin section. Angles and corners should be constructed to permit the flow of material over a radius and not into a pocket or abrupt angle. Bosses and mounting points are frequently the cause of molding troubles and poor surface conditions, in that the normal vertical flow of material is impeded, resulting in flow lines and weakened sections at points where the part should be the strongest.

It should be understood that urea materials cannot be merely compressed in the molding operation. Some flow is required to ensure cure and strength as well as finish. Since urea molding materials are used primarily because of their beauty, and since they, by their colorful and translucent appearance, show molding flaws more easily, more care is necessary than with the more opaque phenolic materials.

It must be stated in no uncertain terms that a designer of any new application for urea molding materials should study thoroughly the material's characteristics and work in close contact with an experienced molder. Much grief can be eliminated if the molder is consulted regarding general design and application. The molder should in turn work as closely as possible with the raw material producer regarding the type material required, the plasticity or flow, and the desired service conditions. The development of the radio cabinet and housing applications for urea products was not an overnight occurrence; the process has been an evolutionary one, and has been made possible by accurate control of materials and a greater knowledge of the product's molding characteristics in the tool shop and molding shop.

The second great development of the past year has been in the wider use of urea products for lighting applications; this development is also the result of a recognition of certain properties in which the urea plastic is superior to other products.

Urea moldings in their unpigmented form have unusual qualities of light diffusion. Even through unusu-

ally thin sections, it is difficult to see any glare of bulb.

The illuminating engineer has several other important weapons at hand to exploit new ideas for lighting with this material. He has, first of all, a molded product which may be formed into many intricate and varied shapes without a corresponding increase in die cost. The engineer is assured of exact reproduction of these shapes, and is also assured of a duplication of his original color or light efficiency.

Within any given design, there are several methods of altering light output, or the character of the light output. The color may be altered and held within extremely narrow limits; the degree of light transmission and reflection may be varied over a wide range by changing the formula of the material; decorations may be varied in many instances by the use of mold plugs or removable rings in the mold.

Aside from the general features of construction mentioned above, the designer has a new material with unusual physical properties. Molded urea lighting reflectors weigh about one-third to one-fifth as much as glass. This feature, combined with the great shock resisting and shatter-proof qualities of the material, fits it for many novel uses. The "pin-up" lamp, for example, which is hung on the wall, is made more practical and efficient because of the addition of a light weight plastic reflector. Overhead reflectors of sizes ranging from twenty-one inches to twenty-six and one-half inches may now be mounted without danger and without the need for heavy supports. Cleaning these great basins is less hazardous—and if the bowl does fall, the danger of small cutting particles flying through the air or remaining underfoot is non-existent.

The bridge lamp or floor lamp, using a plastic reflector, has a much lower center of gravity and is, consequently, more "tip-proof." In a home where children are at play, the use of such reflectors on floor lamps introduces an additional factor of safety.

The illuminating engineer has made great progress over the past year with this new lighting material. The greatest developments have occurred in the production of large units and more readily adaptable forms. At the beginning of the last year, two urea reflectors of different design were introduced, measuring twenty-one inches in diameter. George Ainsworth of Ainsworth Lighting, Inc., developed a reflector on the Magna principle which can be used with bulbs up to one thousand watts. The Chase Brass and Copper Company added to its already extensive line a twenty-one inch reflector, designed for use with a five-hundred-watt bulb. Very recently the Wakefield Brass Company developed a urea bowl measuring over twenty-six inches in diameter, which at the time was the largest plastic reflector produced in the United States.

This leaning toward large reflectors indicates the lack of limitations which weight and form have on lighting development. These same points have led to another development in the field of lamp reflectors. Since the Illuminating Engineering Society popularized scientific lighting for the home and (Continued on page 84)

# VINYL RESINS (INCLUDING POLYSTYRENE)

by GEORGE C. MILLER

VINYL RESIN PLASTICS IS AN OLD TERM TO THE chemist perhaps, but a relatively new and increasingly important one to industry. Some of these materials have been known for a hundred years or more, but it is only within the past few years that steps have been taken to produce them in quantity. These resins have become available commercially due to intensive research on production of base materials and means of converting such base materials into products of controlled quality at a reasonable cost.

Vinyl resins are polymerization products, the now generally accepted theory being that the polymers are formed by self addition of the monomer to form a long chain molecule, the length of which is determined by the reaction conditions. The properties of the resins depend on the monomer selected to start with, or the monomer ratio, if a copolymer is desired. Properties also depend on distribution of high, low and intermediate polymers in the resin. It is therefore possible to produce vinyl resins with rather widely varying properties, to meet specific industrial needs.

Vinyl resins are thermoplastic, that is, they do not undergo a chemical change under ordinary conditions of

forming or processing. The resins are molded under heat and pressure, and pieces so molded, as well as all flash and rejects, may be remolded just as readily as the original piece.

These resins, in general, are clear, tough, odorless, tasteless, non-toxic, non-burning or slow burning. They may be applied in solution, calendered, molded and extruded, with or without fillers and pigments.

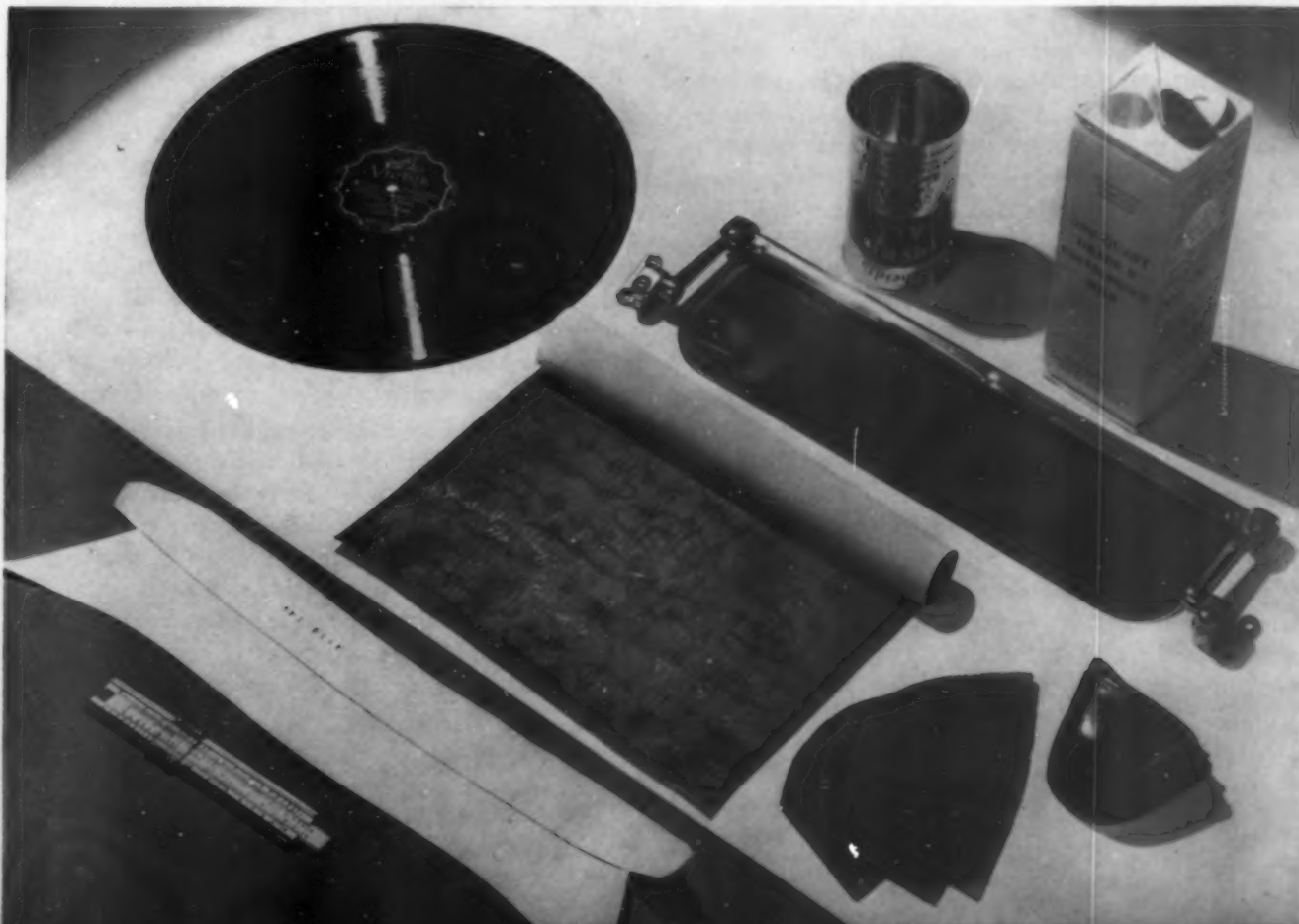
## Polystyrene

Polystyrene is not a new resin, by any means, but its commercial development has necessarily been slow, due to the fact that until recently methods had not been developed for production of the monomer on a commercial scale at a cost that would permit more than a few specialty uses for the polymer. Effective methods for producing monomeric styrene commercially, as well as improved methods for producing the polymer in grades of uniform quality, have now been worked out. The resin is being produced in both Europe and this country, although domestic production is still somewhat limited.

Perhaps the most significant properties of polystyrene are its low power factor, and its practically zero water

A variety of items are made from vinyl acetate-vinyl chloride copolymer such as records, beer can linings, slide rules, interliners for "starchless colors," cloth, sun visors, and shoe toes. Poly vinyl acetate is used as the adhesive for sealing milk cartons

CARBIDE & CARBON





Dentures, telephone handsets, picture frames, steering wheels, clock cases and platters are only some of the uses made of Vinylite resin

absorption. These remarkable properties make polystyrene exceptionally well suited for radio frequency insulation, the resin being fully as good as fused quartz for this purpose, and definitely superior to any other resin thus far developed.

The resin is supplied in granular form. It is colorless, tasteless and odorless, and has practically no cold flow at ordinary temperatures. It has excellent heat and light stability, and is resistant to moderately strong acids, alkalis and alcohols. The resin is soluble in chlorinated hydrocarbons, esters, dioxan and aromatic hydrocarbons, and is affected by aliphatic hydrocarbons and acetone. Plasticizers such as dibutyl phthalate, dibutoxyethyl phthalate, tricresyl phosphate may be used with polystyrene. Of course the addition of plasticizers or fillers will affect the electrical properties of the material somewhat. Polystyrene may be press molded, injection molded or extruded with standard equipment, and it may be readily polished or machined.

Now that effective methods of production of both the monomer and the polymer have been worked out, the very desirable properties of polystyrene will undoubtedly result in the adoption of this resin for an increasing number of industrial uses. Present price of the resin is higher than some of the other synthetics, due to limited production. Production facilities will be increased to keep pace with increasing demand, and prices should be reduced considerably as volume grows. Some physical properties are listed in the Plastics Properties Chart at the end of this section.

### Poly vinyl chloride

Vinyl chloride is polymerized in the presence of a catalyst to form poly vinyl chloride, which is produced in the form of a fine powder. Properties of this resin are influenced by conditions of polymerization, although perhaps to less extent than some of the other vinyl polymers. High polymer is soluble to but small degree in acetone, dioxan, chlorinated hydrocarbons, mesityl oxide, at room temperature, but may be dissolved readily by these materials, with the exception of acetone, at elevated temperatures. As the polymer size decreases, solubility increases, and softening point is lowered.

The resin has a specific gravity of 1.4. The refractive index at 20 deg. C. is 1.544. It is odorless, tasteless, has a high degree of resistance to concentrated acids, alkalis and alcohols. Water absorption is practically nil, and the resin will not support combustion. The resin is somewhat cloudy, is rather brittle, and has too high a softening point to be worked on ordinary milling, calendering and molding equipment, unless plasticized.

The plasticized resin, however, has found wide industrial acceptance for those applications requiring a resilient rubber-like material, where rubber fails to meet the conditions of service, the plasticized poly vinyl chloride being far superior to rubber in flexing life, resistance to sunlight, water, oxidation, acids and certain oils. The plasticized material may be milled, calendered, extruded, and molded with standard types of equipment, and is being widely used as extruded coatings on low voltage

cables, coverings on various small friction rollers in textile mills, and as sheet packing for many applications for which rubber is unsuited. It is also replacing glue-glycerine molds in the plaster casting industry. Other of the many industrial uses for the plasticized material are discussed by Brous and Semon.

### Poly vinyl acetate

Poly vinyl acetate is produced by the polymerization of vinyl acetate in the presence of a catalyst. The resin is supplied commercially in the form of a granular powder of about 8 to 10 mesh. It is water white in color, odorless, tasteless, non-toxic, and will burn slowly with a smoky flame. It is soluble in the lower molecular weight alcohols, ketones, esters, chlorinated and aromatic hydrocarbons, and insoluble in water, aliphatic hydrocarbons, fats and waxes. A number of the phthalates, phosphates, tartrates and glycolates, are satisfactory plasticizers, for example, dibutyl phthalate, tricresyl phosphate (lindol), dibutoxyethyl phthalate (Kronisol), butyl phthalyl butyl glycolate (Santicizer B-16) and 3-GH. In proper solvent combination, the resin is compatible in all proportions with nitrocellulose, and to lesser degree with certain other natural and synthetic resins, such as shellac, elemi and ester gum, dammar and rosin. Some of the physical properties of this resin are listed in Table I.

TABLE I

|  |   |                |
|--|---|----------------|
| Specific Gravity   | 20° C.  | 1.191          |
|  | 20° C.  |                |
| Tensile Strength   | Approx. 5000 lbs./sq. in.   |                |
| Refractive Index   | 1.4665 @ 20° C. $\frac{N}{D}$   |                |
|  | 1.4483 @ 80° C. $\frac{D}{N}$   |                |
| Burning Rate   | Slow Burning  |                |
| Electrical Properties:   |   |                |
| a. Dielectric Strength (Approx.)   | 1000 V/mil in air @ 60 cycles   |                |
| b. Surface Resistance  | Infinity  |                |
| c. Dielectric Constant   | 30° C.  | 60° C.         |
|  | 2.7   | 6.1            |
| d. Power Factor  | 0.025 (30° C.)  | 0.070 (60° C.) |
| Aging  | Unaffected  |                |
| Light Stability  | Unaffected by direct sunlight   |                |
| Heat Stability   | Unaffected at 200° C. 1 hr.   |                |
| Viscosity (Percent solids required to give a viscosity of 110 $\pm$ 10 centipoises @ 20° C. in methyl isobutyl ketone) | Resin AYAA—27½% Solids<br>Resin AYAF—21% Solids<br>Resin AYAT—18% Solids  |                |
| Initial Heat Distortion Point (A.S.T.M.)   | Approx. 38° C. for all above grades   |                |
| Heat Sealing Temperatures  | AYAA—Approx. 105° C.<br>AYAF—Approx. 130° C.<br>AYAT—Approx. 150° C.  |                |
| Water Absorption (A.S.T.M.)  | 2% in 144 hours. Increases on longer immersion  |                |
| Water Immersion  | Swells, becomes leathery and pliable when large amount of water has been absorbed. Surface unaffected after drying. |                |

### Uses

Poly vinyl acetate, without filler, becomes very tacky at temperatures of 200 deg. F. or over, and adheres strongly to almost any surface it is pressed against while

hot. It forms a strong, tough bond when cool, and is being used extensively as a thermoplastic adhesive for fabric and paper. Its adhesive qualities, coupled with the lack of color, odor or taste, make it ideally suited for the sealing of paper drinking cups and milk containers. It is also used for sealing of glass bricks, sealing metal foil to paper backing, as the binder for plastic wood, as the binder for various fillers for the molding of period reproductions, advertising signs and novelties, and as a coating on paper for non-aqueous gumming tape.

The resin is usually applied in solution to the stock to be sealed, the solvent being evaporated by heating. However, in case a low viscosity resin is used, it may be applied as a hot melt, without the use of solvents. In either case the material may be applied to the stock by a roll, either across the full width of the stock, or printed in spots as required. The dry resin heat seals to itself or other surfaces easily at temperatures of 200 deg. F. to 250 deg. F. and moderate pressures.

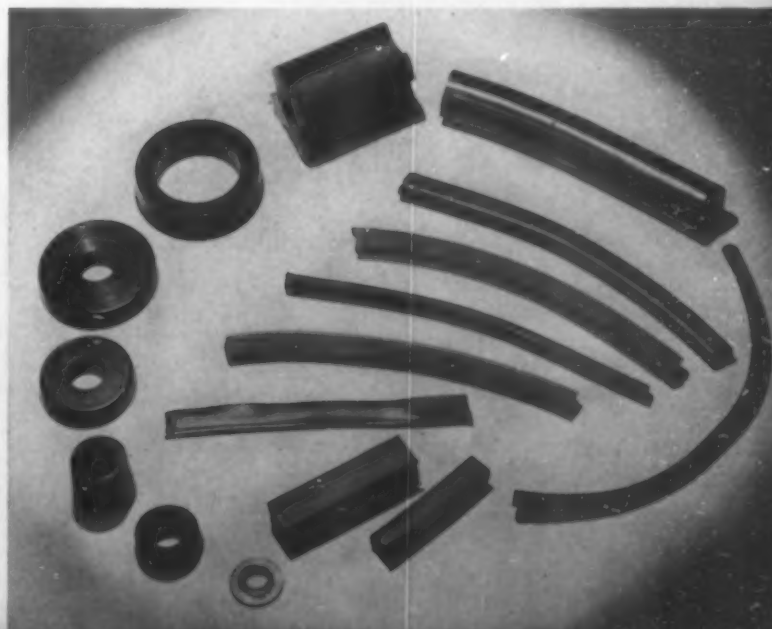
Solutions of the resin are also used as a cold adhesive for sealing of leather, clear cellulosic films, sealing of "tamper proof" bottles, and sealing of nitrocellulose sheet around wooden shoe heels. Since the resin is water white and has indefinite outdoor stability, and good adhesion, it is an excellent vehicle for metallic paints. It is also used extensively in the manufacture of plastic wood putty.

### Vinyl acetate—aldehyde resins

These resins are formed by replacing part of the acetate groups of poly vinyl acetate with an aldehyde. Properties of the resin vary, according to the viscosity of the poly vinyl acetate used for conversion, as well as with the percentage replacement by the aldehyde.

Acetaldehyde replacement resins are slightly yellow in color, are odorless, tasteless, and have excellent heat and light stability. As previously mentioned, the properties vary according to grade of poly vinyl acetate used, and percentage replacement by the aldehyde. In general, however, these resins have a 40 deg. C. to 50 deg. C. higher softening point than the poly vinyl acetate used as base material, and are considerably tougher and harder. Most grades are (Continued on page 106)

Miscellaneous extruded and molded shapes of Koroseal



# WHY FILLERS IN THERMOSETTING MOLDING MATERIALS?

by VIRGIL MEHARG

AS THE YEARS HAVE PASSED SINCE THE EARLY development of plastic molding materials, greater importance has been assumed by the types of fillers employed in their manufacture. Often, variations provided by the choice of filler are very important, and a proper appreciation of these possibilities is a deciding factor in the selection of the correct molding material for a specific application. However, in spite of the improved mechanical and physical properties which filling agents impart to molding materials, the all-important ingredients are the resins which provide plastics with their distinctive characteristics. This might further be emphasized by the statement that in any proposed application of a molded plastic, the correct filler represents one variable, but the possibilities in the resin represent an almost infinite number of variables.

Although thermosetting molded plastics have been in use for more than twenty-eight years and have thoroughly proved their worth to industry, their continued development through sustained research is leading daily to new applications, and is furnishing solutions to problems which have hitherto been found impossible or impracticable in actual use. Continuous search for new filling materials together with improved resins and the new types of resins has resulted in plastic molding materials that can hardly be said to resemble their predecessors in appearance, physical or mechanical properties.

Fillers were first employed in an effort to lower costs of molding material. This factor is still important, but it soon became evident that resin-filled molding materials possessed particular advantages. These advantages

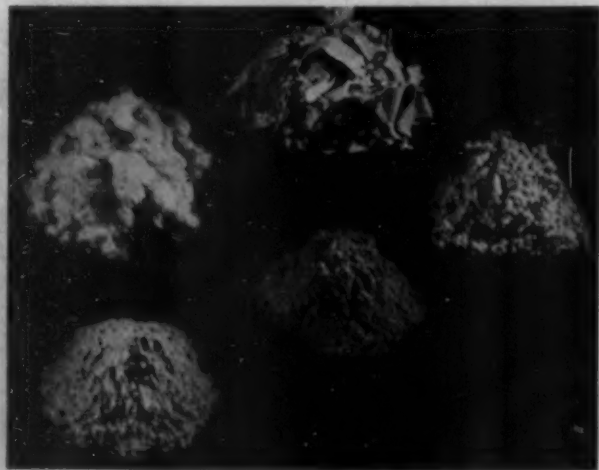
may be briefly listed as follows:

- (1) Greater speed of molding
- (2) Closer tolerances obtainable in the molded piece
- (3) More constant strength characteristics
- (4) Special characteristics of the fillers, allowing the development of molded parts possessing these special properties to a marked extent

The first of these points is the prime reason for the rapid rise of the molding industry. It has allowed this industry to find for itself a place in present-day mass production methods. Molding time has been continually cut, with consequent saving in costs. Improvements in molding technique and increased speed of cure may further reduce operating cycles.

The lower shrinkage of the molded piece has enabled the production of more intricate pieces, together with greater assurance that close tolerances can be held, both during and after the molding operation. When fillers are added to some types of plastic materials, their effect on physical properties is a mere dilution, resulting generally in loss of strength and other properties. In the case of the thermosetting phenol and urea resins, this most happily is not the case, particularly with fibrous fillers. Such fibrous fillers, at the worst, result in only slight loss in strength and, at best, greatly improve the molded piece. In addition, such filler-resin moldings show greater uniformity of strength properties; and the variations occasioned by slight changes in molding technique are greatly decreased.

Figs. 1 and 2. Typical fillers used in thermosetting molding materials: fabric filler, cotton flock, shearings, alpha pulp, woodflour, long fiber asbestos, litharge, mica, short fiber asbestos



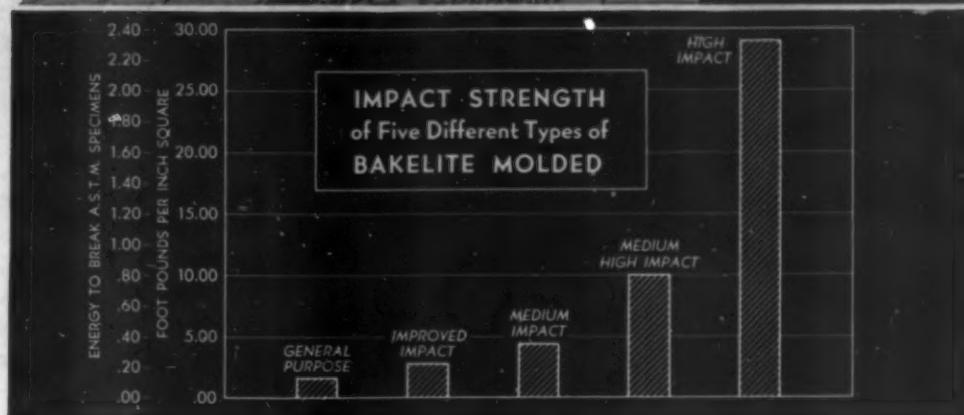


Fig. 3. Range of impact strength for five different types of phenolic molding materials

Fillers may be roughly divided into organic, carbon and mineral types. This, of course, does not refer to materials which may be classified as pigments, since these are used in relatively small amounts. The two classifications are given following, together with the principal raw materials.

#### Organic fillers

Cellulose derivatives, such as

- (a) Woodflour
- (b) Cotton
- (c) Paper or pulp
- (d) Textile by-products

#### Carbon fillers

- (a) Graphite
- (b) Carbon black

#### Mineral fillers

- (1) Asbestos
- (2) Mica
- (3) Lead oxide
- (4) Miscellaneous, as barytes, silicates, aluminates, zinc oxide, etc.

A number of these fillers are shown in Figs. 1 and 2.

Of all these fillers, woodflour is not only the most widely used, but due to this long and wide use, has become the standard for comparison of properties in the phenolic type of molding materials. This filler is also used abroad for urea plastics, but in this country the preference has been for some more purified forms such as paper pulps.

The reason for cellulose filler preference might be considered briefly. In effect, the purchaser of molded parts buys on a volume basis. The trade molder buys on a price-per-pound basis. The *molded specific gravity*, therefore, becomes of great importance from a cost standpoint. In this respect, cellulose derivatives enjoy

a marked advantage over mineral fillers. This is well illustrated by the following figures which represent *molded specific gravity* of a few common fillers usually obtained in phenolic molded pieces.

- (1) Woodflour—1.36
- (2) Cotton—1.36
- (3) Asbestos—2.0
- (4) Mica—1.90

Pieces molded from material containing high gravity filler are naturally also high in gravity. Thus, on a volume or piece basis, the mineral filled pieces are at a definite disadvantage.

#### General purpose materials

As stated previously, woodflour has become the standard for large volume production of phenolic molding materials. This is due not only to its low molded specific gravity, but also to abundance at low cost, strength properties, good appearance, reasonably good electrical properties, as well as moisture resistance. In short, this filler represents a fair compromise of a great many properties. Although woodflour has attained large volume, and products containing it have properties which are now well known in a general way, developments in this line of materials have by no means stopped. Continued research may in time displace woodflour from its present preeminent position as a filling material. If so, it is likely to be some other cellulose filler, available in large volume at low cost, and enabling the manufacturer to raise the "over-all" properties as well.

#### Special purpose molding materials made with special fillers

Within recent years, a variety of molded products and parts have appeared on the market which have been

designed to accentuate a particular property or combination of properties. In this field, the various fillers, other than woodflour, have justified their use.

#### Improved impact or shock resistance

A whole series of molding materials, having greater impact resistance than woodflour-filled materials, have been developed within recent years. Using a standard test piece with molded-in notch, the energy to break a standard woodflour-filled molding material by Izod test will vary from 0.11 to 0.19 ft. lbs. Such values are sufficiently high for most purposes, but breakage due to shock has often been the cause of failure in service. In these cases, it has actually been found less expensive to replace a woodflour-filled material, which would require a heavy molded section, with a much thinner section produced from impact molding material.

The range of such impact materials is from 0.20 to 2.0 ft. lbs. energy to break. For purposes of description, these impact- or shock-resistant materials may be classified into four groups, i.e., improved impact, medium impact, medium-high impact and high impact. The typical uses to which impact materials of each type may be put are illustrated here. (See Fig. 3.)

Fabric materials, which are used for high impact fillers, are by-products of the textile industry and include clippings, shearings and the like. They owe their strength, not only to the inherent strength of the fiber,

but also to the fact that they are generally spun and woven. These spinning and weaving operations provide an interlacing, cross locking of the fillers, which gives greatly improved impact-resistance in the molded article.

A somewhat lower range of impact molding materials is obtained by use of a paper base. In this case, the pulp fibers, in the process of manufacture on the paper or wet machine, acquire an interlocked structure, although such interlacing is not as complete as in the case of the woven-textile products. Products from these paper-base fillers may produce products in the medium or medium-high impact range.

Due to the length of fiber in the fillers, these materials, particularly in the high impact range, generally require slightly different handling in the molding operation. This is caused particularly by their bulky condition, which necessitates manual preforming before molding. Recent developments have, however, produced materials in the improved and medium impact ranges which are free of this difficulty, and they may be handled in practically the same way as woodflour-filled materials.

The recent use of impact materials for toys is exemplified by the cap pistol shown in Fig. 4. Made with improved impact material, this use marks the successful entrance into a field from which phenolic plastics were for the most part considered impractical. The fact that toys which must withstand considerable abuse can be successfully manufactured from molded plastics presages a host of other articles now made from metal, wood or other like materials.

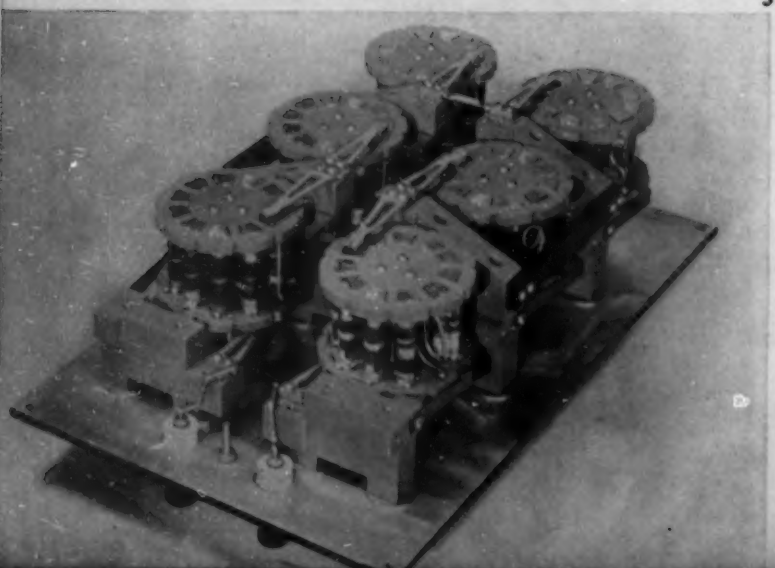
Although asbestos as a filler is used for its heat-resistance, long-fiber asbestos has been used for some years where a molding material of improved impact strength, combined with other properties such as heat resistance, is required.

#### Improved electrical properties

Fillers exert a marked effect on the electrical properties of a molded piece. For some years so-called "low-loss" materials have been finding increased favor for insulation and ignition parts. Mica has been found very useful for this purpose. Mineral fillers of this type show up particularly well at high frequencies. They also maintain their good electrical properties over a range of temperatures. This last factor is one often overlooked, but may easily result in failure if not fully considered. Recently, other mineral fillers of the silicate and aluminate type have been offered to the trade. Although their uses have not yet been extended, the future appears bright. Molding materials made with some of these fillers offer excellent electrical properties, along with improvements in the molding characteristics.

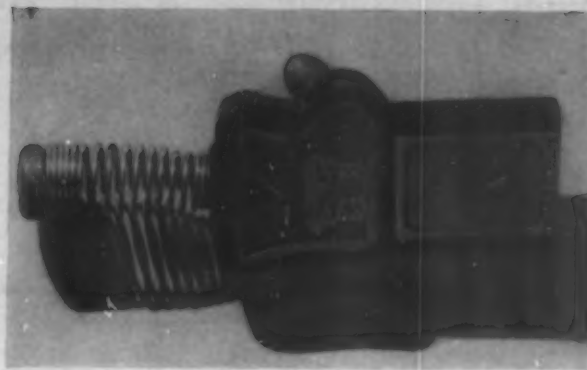
As the result of research within the industry, it is now possible to furnish products particularly adapted to either high or low frequency uses or to constant losses at varying frequencies. These properties have proved particularly attractive to the radio, scientific instrument and automotive fields. One illustration of resistance box drums is shown in Fig. 5. Materials of low loss are likely also to be found good in dielectric

Fig. 4. Toy cap pistol produced from improved impact-resistant molding materials containing cotton flock filler. Fig. 5. Resistance box drums produced from special low-cost molding material having a mica filler. (All photos except Fig. 17 courtesy Bakelite Corp.)

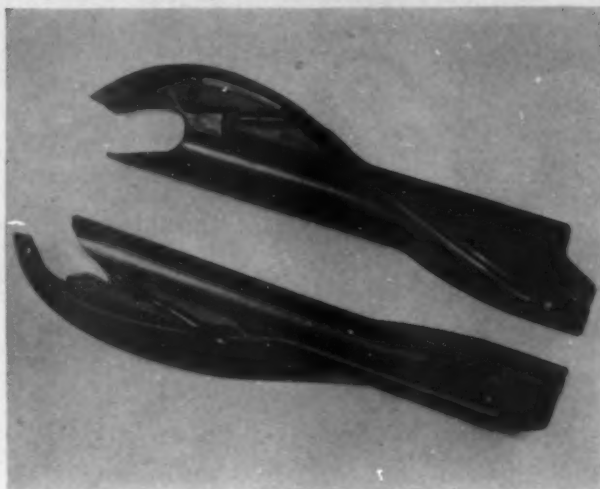




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fatigue, a property which has recently been considered of importance in automobile ignition systems.

#### High-heat resistance

Asbestos as a heat-resistant material is well recognized. It is therefore natural that it should be used where this property is particularly essential. The term heat-resistance may be used to describe at least two, more or less unrelated, phenomena. In the first place, a molded piece may be required not to blister, crack or develop other defects upon being subjected to high heat. In the second place, it may be required to retain its properties on being subjected to high temperatures over extended periods of time, and in addition must not blister.

Thus in the first class we find materials developed particularly for resistance to blistering at high temperatures, such as ash tray molding materials (Fig. 6). Connectors for electric irons and other heater appliances are representative of the second class (Fig. 7). Another interesting application of this type of material is for the sealing wax engraving part shown in Fig. 8.

The question of maximum temperature which a molded piece will withstand for long time periods has been the subject of considerable controversy. As the result of a long and extensive series of tests, the following facts have been found. Specially selected woodflour-filled molding materials will withstand 300 deg. F. without serious loss of strength properties. The highest

heat-resistant materials available today will withstand 475-500 deg. F. in the same test. Several intermediate materials, giving resistances between the above limits, have also been developed and may be employed with a savings in cost, if the application will permit. These materials are also used for cooking utensil handles and a wide variety of heating appliances.

#### High chemical resistance

Although the resin exerts a marked protective effect on fillers, still the extent of attack of a chemical agent on a molded piece will vary to some extent with the filler. For purposes of this discussion, we may consider not only water or moisture, but also acids, caustics and organic solvents as chemical agents.

Improved moisture resistance over woodflour-filled materials may be obtained by the use of mineral fillers. Unfortunately, in this respect the other property demands of the molded article usually dictate the use of a cellulose filler. In this case, cotton has shown some advantage. The telephone handset (Fig. 9) is a good example of where a combination of moisture resistance of a special type (perspiration) and impact resistance is required and a material found to meet these requirements.

The retention of good surface appearance after molding and subsequent storage is often overlooked by the purchaser of molded parts. Surface retention, in many cases, is closely connected with good moisture or water

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"Lucite" methyl methacrylate thermo plastic resin, properties listed at right.

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resistance. This factor should be considered very closely for applications involving displays, or any other use where stress is to be given to appearance for customer appeal. Wherever possible, in such cases, advantage should be taken of mineral fillers with their inherently better properties as mentioned above.

Another most difficult case of water resistance is found in products which must withstand repeated sterilizing in boiling water or steam. The nursing bottle closures, Fig. 10, are examples. Another application has recently been found in handles for medical and other scientific apparatus which must be similarly treated.

For acid resistance, the cellulose fillers are, in general, reasonably good, particularly for weak acids. Even in the case of stronger acids, such as sulphuric, the spinning bucket, shown in Fig. 11, has proved its worth under long usage. The textile and allied fields present many problems involving chemical resistance, which are rapidly yielding to the continued research of the plastics industry. Individual tests are advisable for each application, but recommendations can usually narrow the choice to a few materials.

Mineral fillers, as asbestos, are better than cellulose for alkali resistance. Again, however, other considerations may change the choice. Organic solvents generally show more effect upon the resinous portion of the molded piece, but the tendency of the filler to absorb a solvent may be serious. Thus with woodflour-filled materials, a solvent may extract ingredients from the wood which will impart objectionable odor or taste. In the closure field (Fig. 12), chemical resistance to a wide variety of products is necessary. With its growth in recent years this whole field has brought many problems which have required a large amount of investigation. This has greatly increased knowledge of chemical resistance of molding materials to a wide range of products. Consequently, manufacturers today are not only employing molded plastic closures, but molded containers as well.

#### Light colors and light resistance

The development of light colored, light-resistant molding materials, particularly of the urea type, has led to a

survey of fillers, both for their initially light color and for light resistance. Many urea molding materials, fabricated with a woodflour filler, are sold abroad. This practice produces an opaque product of somewhat inferior light resistance. In this country, the vogue has been toward a translucent molding. For this purpose, woodflour is unsuitable and material manufacturers have turned to bleached pulps, which are very light in color and remain stable to light—conferring the desired translucent effect. It is particularly interesting to note that the urea resins attained no commercial significance until they were used with fillers. Thus, the credit due the filler in this type is even more marked than in the case of the phenolic molding materials.

In the case of both resin types, constant attention to resins and fillers has led to extensive lines of colors which, according to the virtues or limitations of each, have found wide acceptance.

#### Dimensional changes or tolerances

The ability of the thermosetting molding materials to be quickly and accurately formed to shape is one prime reason for their use. The accuracy of this reproduction, as well as retention of these dimensions after the molding, is not always thoroughly appreciated. Although space limitations do not permit an extended discussion of this subject, in cases where dimensional change is very important, the use of mineral fillers is advisable. These fillers, properly chosen, give less initial shrinkage and retain dimensions more accurately, particularly under varying humidity conditions.

#### Friction or anti-friction properties

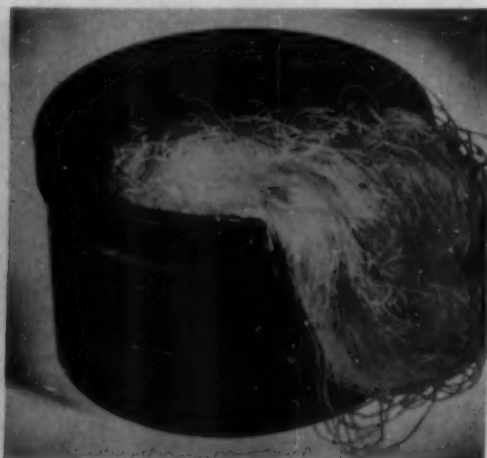
The use of a variety of fillers bonded with phenolic resins to attain high friction is now a well established process of increasing importance in the manufacture of brake lining and clutch rings. Asbestos, carbon black and various inorganic fillers, such as barytes and zinc oxide, may be used.

In addition, various organic fillers, as rubber dust, may be incorporated. Fillers for such purposes must be relatively good in heat resistance, due to the heat de-

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18

veloped in the braking operation—hence, the use of inorganic and carbon fillers.

In contrast to the high friction products, there is a variety of uses for low friction purposes. The molding of casters (Fig. 13) is one of the oldest applications; another of interest is the elevator dash pot. Still another recent development, which involves both low friction and improved impact resistance, has brought forth bumper shoes for automobile doors (Fig. 14). Molded bearings produced from low-friction materials have lately appeared on the market. Cellulose has satisfied the filler requirements in the case of bearings which are lubricated, but for non-lubricated surfaces the addition of graphite in the molding material has proved advantageous in many cases.

#### Odor and taste

In certain uses it has been erroneously supposed that resins, especially the phenolics, are wholly responsible for odor and taste in molded articles. This has not always been true. Woodflour-filled products are particularly subject to question on these points. However, in spite of the inherent difficulties in the use of this filler, intensive research in the last few years has provided a series of products designed to withstand a wide variety of uses. It will readily be understood that odor and taste are usually associated with chemical resistance to the solution under test. Therefore, it is advisable to test each application, although, through experience, the choice can usually be confined to a few materials.

#### Sound transmission and vibrational absorption

The acoustical and sound absorption properties of molded compounds have recently received the attention which their importance warrants. Illustrations of such applications include musical instruments, voice transmission apparatus (Fig. 15), machine parts, such as silent gears and other parts designed for vibrational or

sound absorption. The inter-office transmitter and receiver (Fig. 16) illustrates one application. Molded gears provide another example, although in this case other properties, such as strength characteristics, are also especially important. The recent advances in this field are such that molded plastics should find many new applications for acoustical equipment in the near future. Cellulose fillers have found preference in this field. Wide variations are possible, however, not only in different types of cellulose, but also between cellulose and mineral fillers.

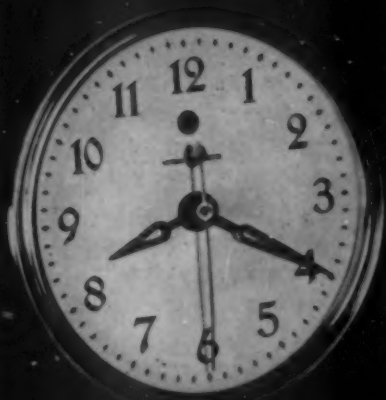
#### Light or spectra transmission or shielding

Transmission, diffusion and absorption of ordinary light, ultra-violet, infra red and various emission spectra as X-ray are all angles of a general problem in which the molding material fillers play an important part. As a general rule, although not without exception, it may be said that fillers tend to absorb light of various wave lengths more than does the resin.

In the case of the translucent urea moldings, the use of fillers to attain the desired transmission and diffusion effects is a good example (Fig. 17). Again, there have been developed molded X-ray shields which represent a distinct advance (Fig. 18) and barium or lead salts, as barytes or litharge, are employed as fillers.

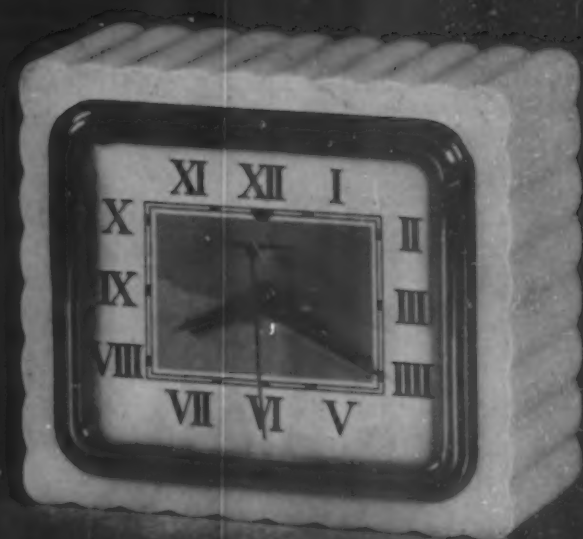
It may confidently be predicted that with experience in the use of various resin types and fillers, a whole range of products of predetermined transmission qualities can be produced, and many of these have already been developed. In conclusion, the use of a variety of fillers has not only increased the usefulness of resins for general purposes, but, by careful selection of the filler, special properties may be stressed, thus fitting molded parts to a wide range of demands not otherwise possible.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.



12

THE BASQUET, Model 3H-78. A dainty octagonal model in Ruted Black or Ivory Fiberlon case. Turn-toed dial, Roman numerals. Height, 4 1/2 in.



9

THE DUNCAN, Model 3F-74. A modern clock in Ivory Fiberlon with black accents. Ivory dial with black numerals and hands. Height, 5 1/2 in.

GENERAL

ELECTRIC



THE ZULEP, Model 7H-80. A smart feminine-style alarm in a Ruted Fiberlon case, available in either wood case or ivory. Height, 4 1/2 in.

3



THE WARRURTON, Model 7H-86. A new-type alarm clock in a case of moulded Fiberlon with a gold enamel-dial. Gray or tortoise-shell. Height, 5 in.



# Time for Fiberlon

Time sells faster in attractive packages. That's why General Electric Company selected translucent Fiberlon cases for these four popular models in its 1937 line. The beauty, versatility, and infinite color range of Fiberlon, which is helping to sell these G. E. clocks, is available to any manufacturer in search of mounting sales.

Fiberlon is a cast phenolic resin, from which these entire clock cases are economically cast in one piece. Fiberlon is also sold in sheets, rods and tubes. Write for details.

**THE FIBERLOID CORPORATION**  
INDIAN ORCHARD, MASS.

New York: Lincoln Bldg.

Chicago: Daily News Bldg.

## LIGNIN PLASTICS

(Continued from page 27) completely dispersed. This makes subsequent handling for curing in large sheets very easy and ensures excellent distribution of material. The fiber structure substantially disappears on curing. The material may also be prepared in powder form.

The curing of a stack of about 150 sheets will produce a one inch slab. Molding conditions vary with thickness and plasticizer content and the variables of time, temperature and pressure are interrelated. The physical properties of the finished sheet are to some degree dependent on these variables.

The plasticizer commonly used with this material is entirely noncompetitive in price. About 3 to 4 percent moisture is all that is required and this is present under normal atmospheric conditions. Where exceptional dielectric properties are desired, it is possible to substitute other materials for this and cure bone dry, but where normal electrical properties are satisfactory, trace of moisture remaining after curing is not serious.

In molding a piece one-eighth inch thick, about twenty uncured sheets are placed in the press and cured about 5 minutes at 175 deg. C. and a pressure of 1500 lbs. per sq. inch. After the press is chilled, the piece is removed with accurately reproduced mold surfaces. A surface film of other resin, pigmented or clear, may be used if desired to secure various surface effects.

The cured sheet has a specific gravity of about 1.43, a modulus of rupture of 15,000 to 20,000 lbs. per sq. in., a modulus of elasticity of 1,500,000 lbs. per sq. in. or more and a water absorption of about 0.6 percent in 24 hours, 0.9 percent in 48 hours, in one week and 5.0 percent in one month. It may be turned, punched, tapped, sawed or drilled, and has wide possible application in the decorative panel field, in automobile construction and elsewhere industrially.

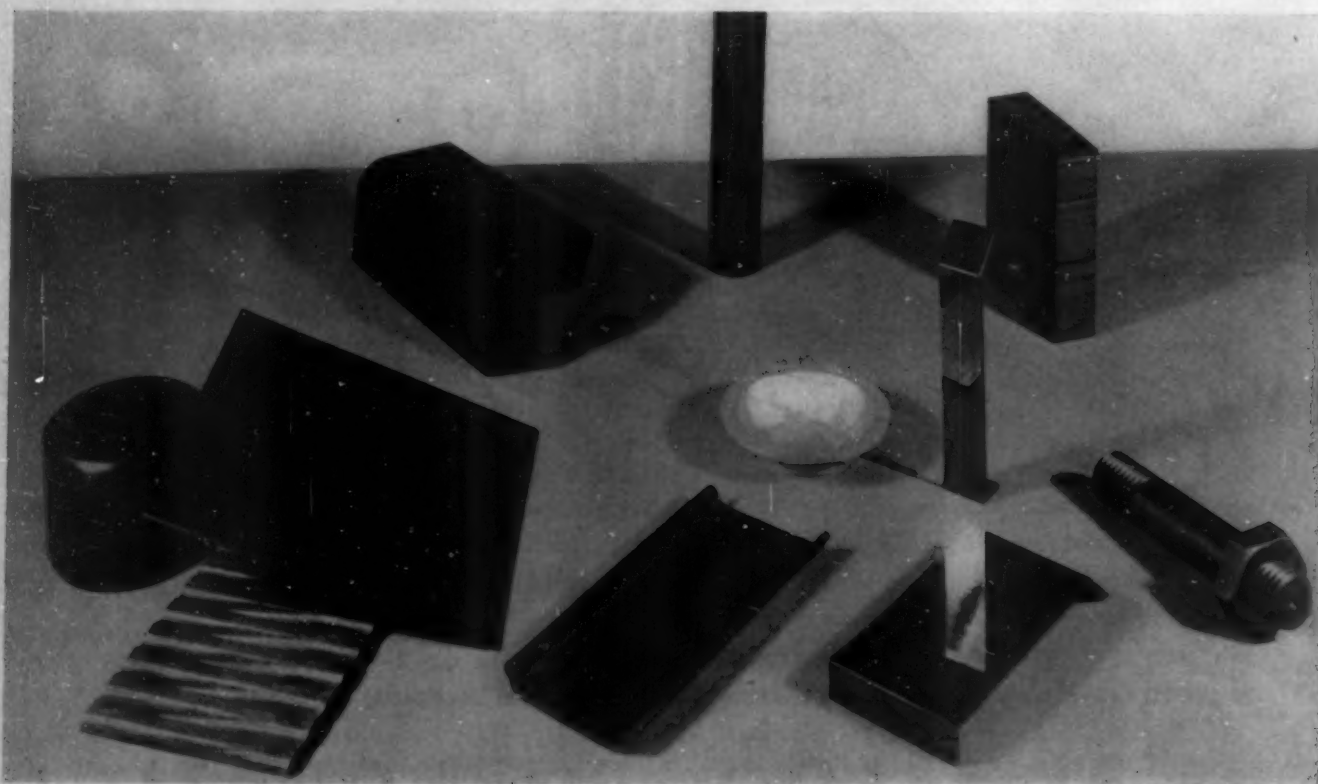
In the decorative panel field, any surface effects may be secured by lacquering a satin finish piece, by curing with surface pigments suspended in resin or by the use of specially prepared surface sheets. Embossed surfaces, inlays and the like may be used. The finished panels may even be cut on the job with a sharp handsaw. With care it may be nailed rather close to the edge, although drilling is recommended. The reverse side may have a rough or offset surface for cementing or applying with mastic.

In the automotive industry its beauty and low cost, combined with good mechanical properties offer many advantages. Exposed edges or openings can be sanded to natural black giving a uniform appearance.

Industrially, the product should find many uses. Since its density is the same as the ultimate density of wood, it is non-compressible and this, together with its high water resistance and electrical properties, makes it a most attractive, low-cost plastic.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

7. Group showing turned, threaded and shaped Benalite



## CAST PHENOLIC RESINS

(Continued from page 19) vertical position. Sheets so cast acquire the same lustrous, smooth finish as the glass.

More than five and a half million pounds of these cast resins produced during the current year have been converted into colorful, novel, saleable consumer products, and their continued penetration into broader ranges of application is due in great measure to their desirable properties and easy-working characteristics. As delivered to the fabricator, they are seasoned and ready for immediate use; their color is uniform throughout any thickness; they are practically unbreakable for commercial purposes and have a high tensile as well as dielectric strength; are non-inflammable, odorless, tasteless, moistureproof and highly resistant to alcohol, oils and common acids. The cast forms need no special machinery to be shaped into finished products, for the same tools, equipment and technique employed in working wood or soft metal are all that is necessary. Dull surfaces occasioned by machining are easily and simply polished to restore the natural brilliance and depth of color inherent in the material.

The jewel-like tones and splendid tactile qualities—never hot or cold to the touch—have a special appeal to women which undoubtedly accounts for the whole-hearted manner in which fashion authorities have endorsed cast resins for high style accessories. Then, too, changing style trends can readily be met with color as well as form, for designs may be altered or entirely revised without appreciable effort on the part of the manufacturer. As a matter of fact, approximately 40 to 45 percent of the cast resin production is absorbed by the button industry, and another 7 to 9 percent appears in the form of costume jewelry. Buttons so fabricated become endowed with a higher service than mere fastenings, for like a piece of jewelry or brooch, they complement a frock and give it an individual touch. Costume jewelry in the form of bracelets, rings, brooches, earrings, clips, etc., are delicately carved, hand-painted or otherwise designed to conform with the current mode as are buckles, millinery and shoe ornaments, umbrella handles, bag tops, cigaret cases, vanity cases, etc.

These versatile materials are familiar in the home where they appear in profusion serving as cutlery handles, brush handles, toilet articles, door knobs, drawer pulls, electrical fittings, decorative shade and lamp pulls, ornaments on curtain rods, napkin rings, handles for toasters and percolators, furniture trim, picture frames, louvres for modern lighting fixtures, refrigerator fittings and as color accent on metal lamps.

Men, too, approve these colorful plastics and make generous use of them as razor handles, desk sets, pipe stems, cigaret holders, cane handles, yacht hardware trim, dice, chessmen, poker chips, ash trays, reel plates, fishing lures, gear shift lever knobs, automobile control buttons, cigaret lighters, radiator ornaments and a host of other accessories too numerous to mention here. However, these few examples serve to suggest the unlimited possibilities offered prospective users of cast resins.



Advertising signs attain new interest and durability when laminated with translucent phenolic resins as do the radio tuning dials shown at the bottom of this illustration. Laminated by Continental Diamond Fibre Co. with resins supplied by the Catalin Corp.

In most instances, cast phenolics are fabricated in the purchaser's own shop but sometimes the user is not equipped to do the actual work and must depend upon fabricators who specialize in shaping the materials for others. Such fabricators, recommended as competent and dependable by cast phenolic producers, are located in almost every large industrial center in the country.

Although not strictly cast resins, other forms of material made from the same ingredients through practically the same process have been added to the cast phenolic family during the current year. Perhaps the most interesting of these is a new thermosetting phenolic molding powder which brings to the molding field the same broad range of colors available in cast forms. This new molding powder inherits the same properties and characteristics of the cast resins—resists heat and acids, is tasteless and odorless—and is to be had in transparent, translucent or opaque forms.

Laboratories and research departments have been intensively developing other new forms of these materials which would be suitable for use as laminating adhesive and surfacing liquids. The field for such resins is very broad and it is, perhaps, in this direction that the greatest effort will be made in the coming year. Already, some laminating resins have been commercially perfected and are being used in the production of radio tuning dials, lamp shades, advertising signs and displays, and other similar products.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

# Catalin...THE Gem



*A Natural Jet Door*

*Jet buttons are the greatest asset to your wardrobe. They are made of the same material as the famous Jet buttons, but are smaller and more numerous. They are made of the same material as the famous Jet buttons, but are smaller and more numerous. They are made of the same material as the famous Jet buttons, but are smaller and more numerous.*

**SAVING COMPANIES** - ONE PRICE BUTTONS, NEW YORK

**Catalin JET**

*Jet buttons are the greatest asset to your wardrobe. They are made of the same material as the famous Jet buttons, but are smaller and more numerous. They are made of the same material as the famous Jet buttons, but are smaller and more numerous.*

**SAVING COMPANIES** - ONE PRICE BUTTONS, NEW YORK

*Beautiful...* CATALIN BUTTONS FOR FASHION

*The development of synthetic plastic buttons such as Catalin goes back to the start of the 20th century. According to the American Plastics Institute, the first synthetic plastic buttons were made in 1900. Since then, the industry has grown rapidly, and today there are many different types of synthetic plastic buttons available. Catalin is one of the most popular and versatile of these materials.*

**SAVING COMPANIES** - ONE PRICE BUTTONS, NEW YORK

**Catalin Jewels**

*These long, slender rods of Catalin are perfect for making necklaces, bracelets, and earrings. They are made of the same material as the famous Jet buttons, but are longer and more numerous. They are made of the same material as the famous Jet buttons, but are longer and more numerous.*

**SAVING COMPANIES** - ONE PRICE BUTTONS, NEW YORK

# OF MODERN PLASTICS



*Catalin* is manufactured in the largest and most modern plant of its kind, to meet the exacting requirements of a wide variety of industries. Through the enterprising spirit and skill of a competent staff of chemists and engineers, *Catalin*, as a material, has been developed from a purely laboratory experiment into a very vital and essential factor in the plastic industry.

*Catalin* is endowed with truly gem-like beauty...plus thoroughly practical properties which permit easy fabrication with standard factory equipment...and its superior electrical, chemical and physical characteristics have won for it universal recognition and success in many diversified industries\*.

*\*To interested manufacturers we will gladly furnish complete information and samples of Catalin on request.*

**CATALIN CORPORATION**  
ONE PARK AVENUE, NEW YORK, N. Y.



*Catalin is a registered trademark*



**ADAPT THIS YEAR...Hudson and Terraplane**  
*"point the way" with Catalin!*

No the 1937 you will be sure can handle the Hudson and Terraplane. For these distinctive vehicles, Catalin is the ideal material. Catalin is a synthetic material that is light, strong, and resistant to corrosion. It is also a good insulator and is easy to work with. Catalin is the ideal material for the Hudson and Terraplane. Catalin is the ideal material for the Hudson and Terraplane.

AMERICAN CATALIN CORPORATION - ONE PARK AVENUE, NEW YORK



CATALIN CORPORATION - ONE PARK AVENUE, NEW YORK



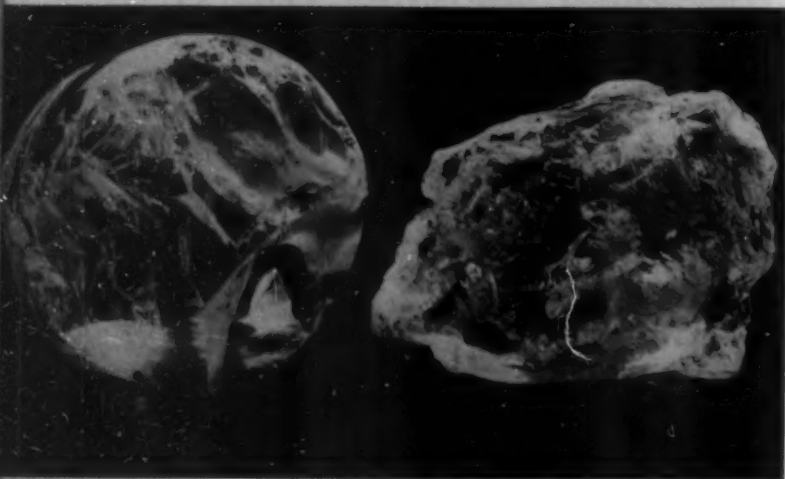
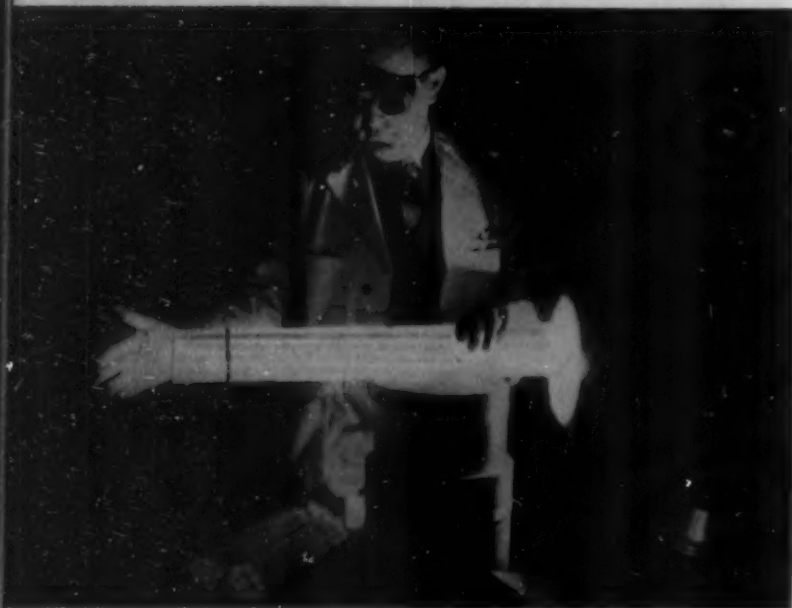
## METHYL METHACRYLATE RESIN

(Continued from page 29)

Semi-automatic molds, adequately cored for heating and cooling and properly mounted in the press, are preferable. Molds of semi-positive or positive type are desirable, and those of positive type can be operated satisfactorily in multiple, if proper provision is made in the form of vents to allow the escape of excess material so as to equalize the pressure on all of the cavities.

Simple molds of flash type can be used with preforms cut from solid material and preheated before being introduced into the molds, but are generally unsatisfactory for the molding powder. But molds of flash type can often be used with the molding powder provided that

Dramatic demonstration of the fluorescence of this amazing new plastic given recently before a meeting of the N. Y. Electrical Society. Lower photo shows comparative refractive qualities of methyl methacrylate (internally fractured) and quartz crystal



they are designed to exert a slight semi-positive effect at the time of final closure. The granular powder can be used also in molds of flash type provided with a top stripper or floating plate which seals the cut-off edges.

A mold of proper type can be closed under high pressure, and the time of closing is dependent only on the rate of flow of the material. Effective heating of the mold and contents is prerequisite to a short molding cycle. If the molding compound has been thoroughly heated during the time required to close the mold, the chilling should be begun as soon as the closing is completed, or even just prior to the instant of final closure. As with other thermoplastic molding compounds, no curing time is required.

The resin is specially compounded for injection molding. The general technique is the same as that for other thermoplastics. It is desirable that the gates or sprue-holes be of generous diameter down to the point of entry into the mold cavity proper.

As a turnery product, methyl methacrylate resin is available in the forms of cast rods and tubes and of cast or molded sheets. As a result of special methods of manufacture, cast rods and tubes can be made completely without taper, being of uniform diameter from end to end. This is of obvious advantage to the fabricator of turnery products, through eliminating the waste and the extra cost of machining which have been involved in handling the usual tapered turnery shapes.

The resin in its pure unplasticized form is usually preferable to the plasticized resin for turnery purposes, because of superior hardness and higher softening temperature. The hardness of surface promotes the obtaining and retaining of a high polish, while not introducing difficulty in machining.

Methyl methacrylate resin may be sawed quickly and cleanly, preferably with a hollow-ground saw with no set and lubricated with water. It may be sliced cleanly on an Oswego cutter or similar machine, provided that it is first softened by heating.

In turning on a hand lathe, best results are obtained with a tool having a flat top and ground to an angle of about 55 degrees. For machine-turning a tool of the same type is recommended, set at an angle of 60 deg. with the spindle. At the preferred speed of about 65 feet per minute, and with a cutting field of about 0.010 inch per revolution, a very smooth finish can be obtained with a depth of cut of approximately 0.020 inch. In working the resin on automatic screw machines and on high-speed lathe or high-speed cutters, water or paraffin oil is desirably used as lubricant, and the material normally cuts clean without chatter marks.

Articles fabricated from cast methyl methacrylate resin are finished and polished by the application of wet pumice and tripoli or rouge, on cloth buffing wheels.

<sup>1</sup> "Modern Plastics," 14, November 1936, page 40; also Ind. Eng. Chem., 28, 1160 (1936); Revue generale des matieres plastiques, 13, 115 (1937).

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

QUALITY ★ UNIFORMITY ★ DEF.

# Reilly INDUR Plastics

## STRENGTH

An important property of Reilly Indur Molding Compounds is strength. In products whose artistic design is a feature, Indur permits faithful reproduction of fine detail. In mechanical or electrical parts, strength makes for lightness and minimum bulk.

Molders find Indur Molding Compounds easy to handle and finished jobs come cleanly from the mold with a high lustrous finish.

Reilly Molding Compounds can serve you to better advantage . . . send for samples or we will be pleased to have our representative call.

# REILLY

TAR & CHEMICAL CORPORATION

EXECUTIVE OFFICES: MERCHANTS BANK BUILDING INDIANAPOLIS, INDIANA

2513 SO. DAMEN AVE.  
CHICAGO, ILL.

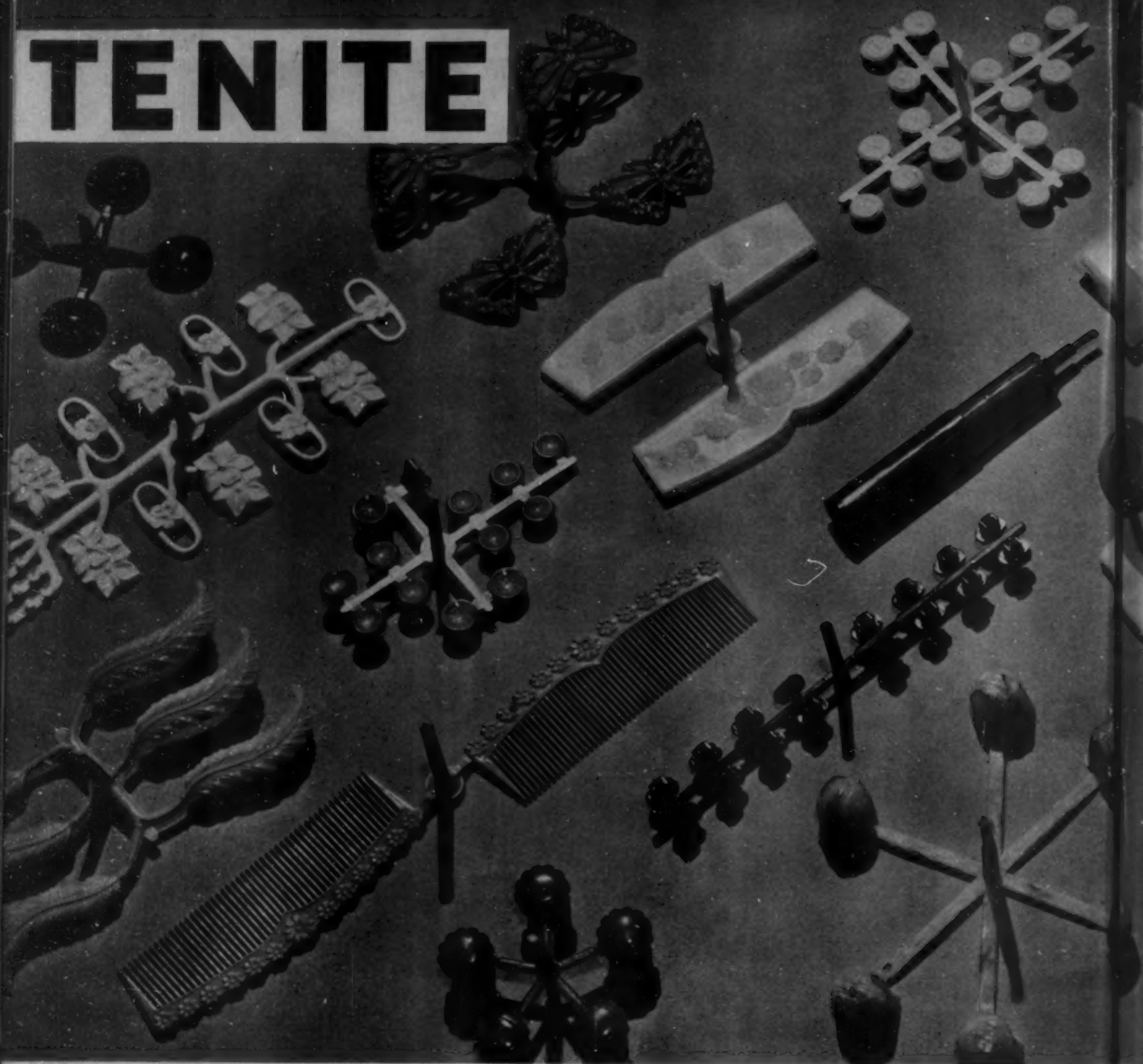
500 FIFTH AVENUE  
NEW YORK, N. Y.

ST. LOUIS PARK  
MINNEAPOLIS, MINN.

OCTOBER 1937

61

# TENITE



**I**NJECTION-MOLDED TENITE has become big news to industry at large. Manufacturers in many different fields are finding that their products can be injection-molded of Tenite, in whole or in part, more economically than they can be made in any other material.

That the Tenite injection process offers sound manufacturing economies is obvious from its adoption by molders of important parts for practically all motor cars—for leading makes of radios, refrigerators, building hardware, office equipment, sporting goods, novelties and toys.

Photographed above are a few typical injected-Tenite products—in the form of castings from single- or multiple-cavity molds. Detached from the gate and runner scrap (which is re-used), the products are complete, or ready for assembly, with little or no finishing.

In addition to the simple types of casting shown here, the injection-molding principle has been extended to the casting of Tenite directly around glass, as a decorative or protective frame. Tenite is also being injection-molded over metal, to replace costlier, less colorful plated finishes.



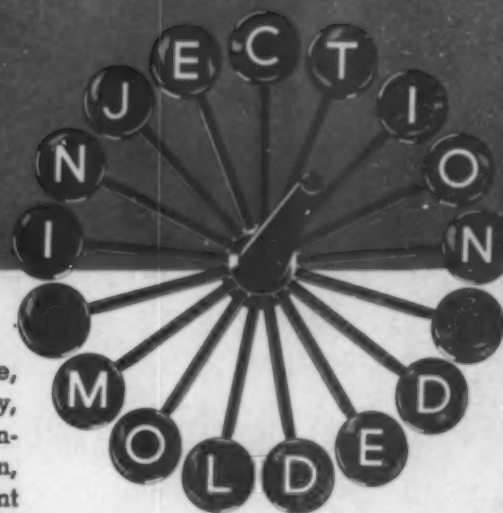
With a molding speed of several "shots" per minute, the fastest ever attained in plastic molding . . . with lower mold costs . . . with finishing operations reduced . . . it is apparent why the Tenite injection process often proves the most economical method of producing an article.

#### Investigate Tenite for Your Product

Tenite, the plastic which has made injection-molding a success, has basic qualities which many products need—

toughness, resilience, low heat conductivity, high luster, and an unlimited range of plain, variegated, transparent and opaque colors.

Custom molders are equipped to mold Tenite—they will gladly tell you about its suitability for your product. You are invited to consult them, or write us direct for a 52-page illustrated book on Tenite, its molding characteristics, and its industrial and decorative uses.



TENITE SALES REPRESENTATIVES: New York: 171 Madison Ave. Chicago: 2264 Builders Bldg. Detroit: 914 Stephenson Bldg. Pacific Coast: Wilson and George Meyer and Company, San Francisco, Federal Reserve Bldg., Los Angeles, 2461 Hunter St., Seattle, 710 Belmont Pl.

**TENNESSEE EASTMAN CORPORATION, KINGSPORT, TENN.** Subsidiary of the Eastman Kodak Co.

## TRANSPARENT PHENOLIC MOLDING MATERIALS

(Continued from page 39)

### Characteristics

#### 1. Appearance

a. These materials, being transparent or translucent, make it possible to produce a depth of color and luster that is most attractive. One class of these materials has such a high index of refraction that it approaches that of the ruby. Molded parts produced from it have a degree of reflected light ordinarily observed only when examining rare jewels.

b. At the present time colors available in these materials include a light transparent shade of amber as a natural color, ruby and green. Tortoise-shell and other mottled and cloudy effects can be produced by the admixture of different primary colors. Light shades of colors and water-clear have not as yet been made available.

c. Color retention or light resistance is always an important characteristic in a transparent plastic. Until now phenolic resins in general have always discolored rapidly under ultra-violet light. The present transparent molding material has extreme resistance to the action of intense ultra-violet light under exposure as long as 72 hours. This is ordinarily considered equivalent to exposure of one year to normal light. At the end of this test a barely perceptible change in color may be noticed.

#### 2. Strength

These materials possess relatively high tensile strength as compared to other transparent plastics. However, they are not unbreakable. For example, they are more resistant to shock than glass, but less resistant to shock than the ordinary thermoplastic materials, such as the cellulose acetates. In resistance to shock they approach the general-purpose, cellulose-filled phenolic materials.

#### 3. General moldability

These materials are capable of being molded to shape, thus eliminating expensive machining and polishing operations otherwise necessary.

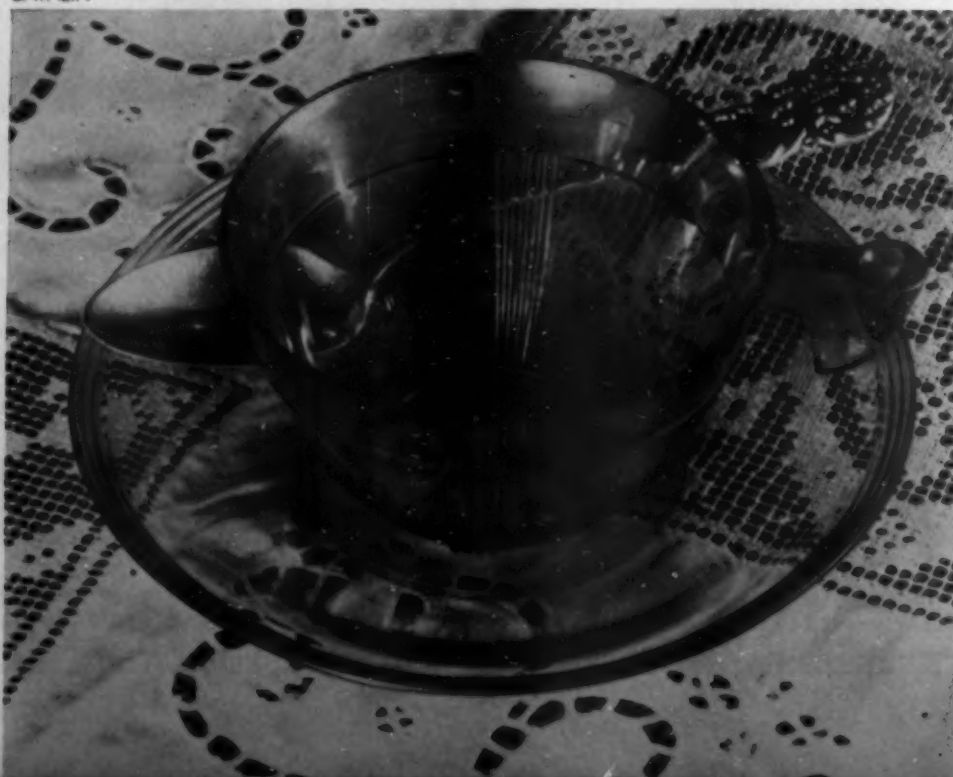
Molding technique for these materials differs slightly from that ordinarily employed for standard molding materials. The molder, therefore, should follow the special recommendations of the material suppliers in order to produce satisfactory parts.

Transparent molding materials open up an entirely new field for plastics since they can be used for such applications as automobile tail and dome light lenses, elevator signal indicators, traffic light signals, instrument housings, transparent containers, furniture drawer pulls, knobs and handles, cutlery handles, gage glasses, electric appliances, lamp shades, refrigerator door handles, buttons, chemical graduates and novelty items.

The Harnischfeger Corporation furnishes an example of how the transparent molding materials can be employed for sales demonstrators. This company manufactures a special type of push button variable speed controller for hoists. Practically the entire unit is produced from opaque phenolic molding materials. To further sales of this new push button, a number of salesmen's samples were molded of transparent molding material. This was relatively simple because the samples were molded in the regular production molds. The company reports that the transparent demonstrator has proved itself a silent salesman. Thus, a customer operates the sample and sees exactly how the inside of the element functions. With the successful development of transparent phenolic molding materials the field for the plastics industry is once again broadened.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

8. Amber cup and saucer, so transparent that one can read a newspaper through them readily. Design and molds by Hurst, Inc.  
CATALIN



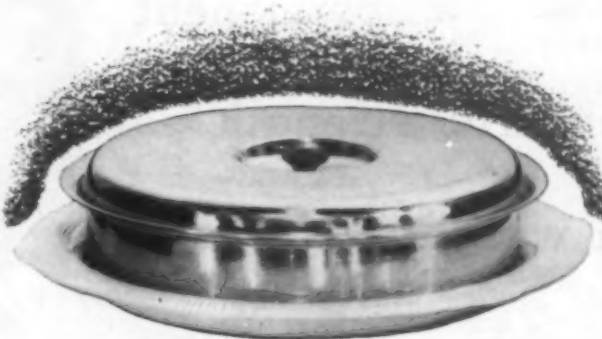
MOLDED

COLOR

Plaskon proudly presents the outstanding plastic accomplishment of recent months—the Home Utility Set. First, because this Set

cause the "Servet" Set illustrates why, during 1937, Plaskon was chosen most frequently where beauty of

"Off the fire—on to the table" is the idea back of "Servet". Meals are prepared in stainless steel ware, by waterless cooking, then placed on heat-resistant Plaskon trays.



Dish and tray go immediately to the table as a handsome ensemble. Five "Servet" dishes fill the requirements of the average household, do the work of twenty conventional utensils.

of "Servet" stainless steel and Molded Color exemplifies hundreds of products improved in 1937 through use of plastics. Secondly, be-

cause the "Servet" Set illustrates why, during 1937, Plaskon was chosen most frequently where beauty of color, texture and finish, together with highest structural and production advantages, were sought in molded plastic products.

**MOLDED COLOR PRODUCTS SELL FASTER**

**BECAUSE:** Plaskon gives products unrivalled color beauty which attracts people most, first . . . Plaskon immediately and evidently assures people of

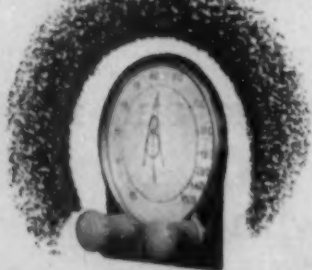


**SCHICK:** A permanent finish ivory Plaskon casing is helping swell current sales of the Schick Electric Razor far beyond the 800,000 Schicks sold in 1936.



**WESTERN UNION:** The familiar blue and white Western Union call box is now giving way in thousands of offices to this immediately identifiable yellow Plaskon housing.

finish, great dielectric strength, is durable, light in weight, light-fast, opaque or translucent . . . Plaskon's



**FORD:** The large, illuminated, non-glare Plaskon dial on the Ford radio is attractive, easy to read, and designed in harmony with other instruments on the instrument panel.

the quality, reliability and service of the product . . . Plaskon has unlimited design possibilities . . . Plaskon has

a permanent



**HARRIET HUBBARD AYER:** Featherweight Plaskon caps and containers engraved with the manufacturer's name, are used throughout the "Campus Kit" to protect all cosmetics.

reputation in

the electrical, packaging, lighting, automotive, and household equipment fields, carries great weight.

**P L A S K O N**

PLASKON SAVES YOU MONEY



COLTS: These eye cups in various Plaskon colors are easily the most sanitary and most successful ever made; brought on the only known boom in eye-cups.

**BECAUSE:** Behind every pound of Plaskon stands top flight quality and uniformity and the assurance that Plaskon will give the greatest ease

and rapidity in molding, consistent with the production of castings of maximum durability and finish . . . Behind



WAKEFIELD: Plaskon makes beautiful reflectors . . . light, tough, free from imperfections, with mirror-like finish. The Commodore, molded of ivory Plaskon, is the largest one-piece reflector produced so far.

when they are needed, and the resources of the world's largest producers of urea plastics.



REMLER: Light-weight, almost unbelievably strong radio cases are made in every color with Plaskon.

the conduct of business of Plaskon Company, Inc., stand two modern plants, assuring quickest delivery of fine molding compounds as and



WESTCLOX: Molded Color steps up wall clocks sales. Reasons: sleek appearance, permanent color, cleanability.

M O L D E D   C O L O R

PLASKON COMPANY INVITES YOU TO INVESTIGATE THE POSSIBILITIES OF PLASKON IN RELATION TO YOUR OWN PRODUCT.

Write today to receive counsel on how to reap high profits from plastics. Plaskon



CHASE: Plaskon handles that will never dent, chip or peel, and are beautiful and pleasant to touch, are a feature of this beautiful new Chase silverware.

Company supplied designing service in the development of the world famous Toledo-Plaskon Duplex Scale, Enterprise Meat Chopper, Wakefield-Commodore lighting units, etc. This same service is yours for the asking. Let Plaskon designers and engineers

answer your questions, and send you complete information outlining the possibilities of using Plaskon on your product. Address Technical Dept., Plaskon Company, Inc.



ACME: The durable Molded Color base of this electric shaver mirror is an example of the use of Plaskon for a large, intricate molding. Inside the sturdy base are stored razors and other accessories.



OBSERVATORY: Modern packaging's newest idea—Plaskon plus Lucite—as utilized in a sales record breaking package for watches.

PLASKON COMPANY INCORPORATED

NEW YORK CITY

41 EAST 42ND ST.

TOLEDO, O.

2121 SYLVAN AVE.

CHICAGO, ILL.

919 NO. MICHIGAN AVE.

CANADIAN AGENT: CANADIAN INDUSTRIES LIMITED, MONTREAL, CANADA

## CELLULOSE ACETATE PLASTICS

(Continued from page 21) similar to C, having very low elongation, and they will therefore, have a low *tensile product* and be brittle as compared to cellulose acetate plastics.

The high *tensile product* of cellulose acetate plastics manifests itself in a great many applications. It is because of this high *tensile product* that we can hammer nails through cellulose acetate airplane windshields without developing cracks, and that the pilot can take the most hazardous power dives without having to fear that the windshield shall break under the strain and blow in his face. The high *tensile product* shows itself in the strength and snappiness of cellulose acetate playing cards. It permits us to use cellulose acetate in molding around a metal core for steering wheels which must remain intact through all kinds of abuse and strain and in all kinds of weather, hot or cold. You are familiar with cellulose acetate handles on screw drivers or chisels, where it must withstand hammer blows. No other plastic has such strength. And this toughness depends upon *tensile product*, the product of *tensile strength* and *percent elongation*. You should, therefore, always insist upon learning what the corresponding elongation is when advised about the *tensile strength* of a product. And furthermore, ask for these figures determined both at room temperature and at 32 deg. F. or 40 deg. F., so you may know what to expect in cold weather. We are continually striving to improve the *tensile product* of cellulose acetate plastics. Fig. 2 shows that from 1932 to 1937 the *tensile product* of one manufacturer's cellulose acetate plastic increased from 180 to 274, an increase in toughness of 52 percent.

### Relation between physical properties

The physical properties of cellulose acetate plastics may be modified more widely than those of any other plastic without sacrificing the basic strength of the material. To possibly give the fabricator and consumer a better understanding of this material we will discuss briefly the inter-relation of physical properties. Cellulose acetate plastics in the form of sheets, tubes, rods or molding material may be called a colloidal solid solution of cellulose acetate and plasticizers. We can vary greatly the type of cellulose acetate in respect to its viscosity, solubility in organic solvents and plasticizers, and its plastic flow under heat when combined with the plasticizers. We can also vary the type and total amount of plasticizers to obtain specific properties.

We will show here only the general trend as we vary the total amount of plasticizers. In Fig. 3 the curves indicate the variation in properties as we increase the total plasticizer content from 20 to 70 parts per 100 parts of cellulose acetate.

1. Tensile strength decreases. Curve 1.
2. Percent Elongation increases. Curve 2.
3. Tensile Product remains high throughout the range, but passes through a maximum around 40 parts of plasticizer. Curve 3.

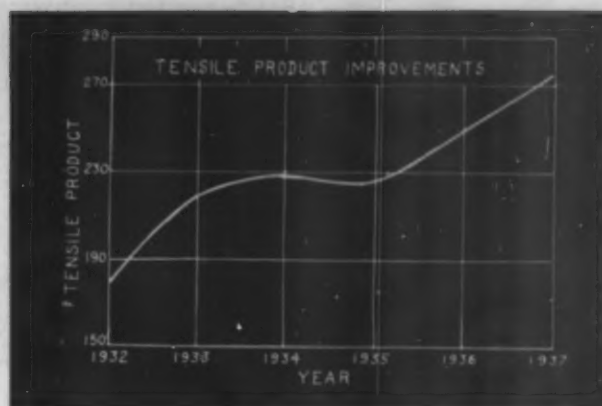


FIG. 2

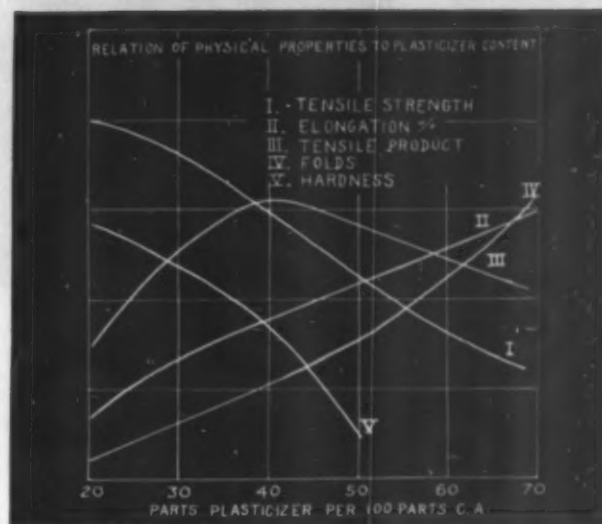


FIG. 3

4. Flexibility (i.e., fold number) increases. Curve 4.
5. Hardness decreases. Curve 5.
6. Cold Flow increases.

These changes take place simultaneously as plasticizer content is changed. We note the versatility of cellulose acetate plastics. Between the figures 25 and 70 parts of plasticizer in Fig. 3 we find that we have a high *tensile product*, and a wide variation in properties is possible within this range without sacrificing the basic strength of the material. But this inter-relationship also limits the types of materials which can be produced. If you want a very flexible material the hardness of it will be less. If you want a very stiff product you may not be able to stitch it in a sewing machine unless you warm it up slightly. The *tensile strength* of it will be high but the important *tensile product* has come down.

Much has been said about camphor as the ideal plasticizer for pyroxylin plastics. The plasticizers we now have available for cellulose acetate plastics are already so satisfactory that the trade can obtain cellulose acetate sheets of better heat shrinking and aging characteristics than pyroxylin plastics. The importance of this is obvious for numerous applications. Let us only mention lamp shade sheets, or a molded threaded article like a fountain pen or an article where you have a friction fit. Cellulose acetate plastics have a slightly higher water absorption than pyroxylin plastics. They will absorb



6. Costume jewelry in a variety of colors and shapes are fabricated from Plastacele a cellulose acetate material. 7. Pastel color effects are available for lamp shades of plastics. (Photos courtesy du Pont Co.)

from 1.5 to about 3 percent moisture when exposed to 95 to 100 percent humidity over 48 hours, depending upon the particular compounding. This moisture absorption is followed by a small expansion. When brought back to normal humidity the piece will contract to its original dimensions. The total variation is not great. It may vary from .3 to .6 percent but should be taken into account when printing multicolored cards for example.

The past year has seen a vast expansion in the use of cellulose acetate sheet stock. It was already well established for lamp shades, playing cards and the printing trade generally. Huge quantities have been used in laminated glass. It goes into outdoor and indoor advertising signs, as formed or molded letters for price tags in the retail stores or as large formed letters on outside attraction signs blazing in color at your home movie.

New applications are found for cellulose acetate plastic in the electrical industry where its exceptionally good insulating properties and high dielectric strength are welcomed. Persistent research has pushed the cellulose acetate plastics to its present preeminence. Within the past six months great improvements were translated into commercial sheet stock for airplane use, mathematical stock and watch and instrument crystals. The light transmission in  $\frac{1}{8}$  in. thick sheets is now close to 90 percent and simultaneously the strength, surface permanency and weathering characteristics were advanced. Such cellulose acetate sheets under test have outlasted by several hundred percent pyroxylin sheets heretofore used in airplane enclosures.

In the container and wrapping material field, the clear transparent cellulose acetate sheet stock has accomplished nothing less than a revolution, as a visit to many big retail stores will tell us. The growth increases by more than 100 percent annually. The permanency, brilliancy and low shrinkage quality of cellulose acetate plastics are of importance here, as are also its cleanliness and sanitary features. This is illustrated by the inability of mold growth to penetrate it, even in a thickness of less than one thousandths of an inch.

### Thermoplasticity

We may explain the thermoplastic properties of cellulose acetate plastics as follows: If we heat glass slowly to above red heat it gets gradually softer until finally we can shape or blow it into different forms or articles, to mention bottles and table glassware only. Glass is thermoplastic. Upon cooling it gets hard again without undergoing any chemical changes, and we can remelt our bottle if we like. This same property is inherent in cellulose acetate plastics. Only we do not have to heat them to such a high temperature as is required for glass, and yet, they are enormously stronger and tougher than glass. If we want to change the form of a cellulose acetate sheet or rod, we heat it to 210 to 270 deg. F. only, and let it cool down again while held in the desired shape. If we want to mold it by pressure molding, we heat it to 270 to 330 deg. F. If it has to soften still more, as required by the injection molding process, we heat it to a temperature of 300 to 400 deg. F. During these manipulations no chemical change takes place in the cellulose acetate plastic. Articles and scrap can be reformed and remolded. If the cellulose acetate plastics are kept for an excessively long time at these high temperatures, they are apt to char and discolor, of course. We must remember that they are of organic nature. You don't leave your wet clothes to dry on a red hot stove when you have been out fishing.

Injection molding has expanded rapidly during the past few years and cellulose acetate plastics have had no serious competition in this field in the U. S. A. There are other thermoplastics that can be injection molded, but they have disadvantages which to some extent have retarded their development in this application, and we may expect cellulose acetate plastics to hold the lead. As most of you know, injection molding consists of the following steps. The finished cured plastic material in the form of granules is fed into a heating cylinder externally heated by hot oil or electric resistance wires. Gradually the material reaches a temperature of 300 to 400 deg. F. at the front end of the heating cylinder (nozzle). A piston under high pressure then enters the back end of the heating cylinder, and the soft plastic is pushed at high rate through an orifice in the nozzle leading into the cavity of the closed mold. The mold is usually water cooled, and the hot plastic, after completely filling out the mold cavity due to the pressure exerted through the soft material from the piston, cools down rapidly in contact with the walls of the cold mold

# MASURON

ACETATE MOLDING COMPOUND  
An Ideal Thermo Plastic with Unlimited Applications  
POWDER SLABS

## Masuron

is available in 24 grades of hardness, flexibility and other physical properties.

## Masuron

is being used for both injection and conventional "pressure" molding.

## Masuron

may be had in transparent, translucent and opaque colors and in various mottled effects.

## Masuron

has been in use since 1927 in many fields—electrical, novelty, etc.—and has proved its workability and uniformity under the severest conditions.

*Masuron is suitable for injection molding on any of the following machines:*

Reed-Prentice  
Eckert & Ziegler  
Alberta & Klingelhofer  
H. P. M.  
I. M. C. Lester  
I. M. C. Isoma

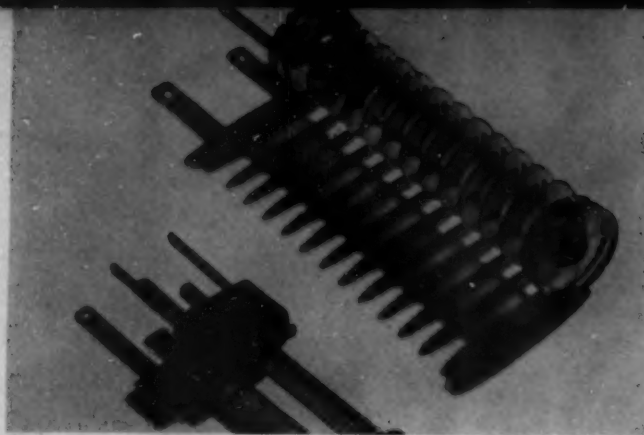
as well as on all types of standard presses.

JOHN W. MASURY and SON

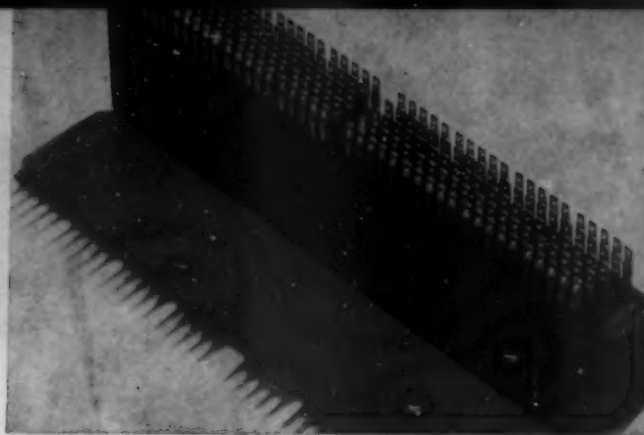
Masuron Division

48 JAY STREET

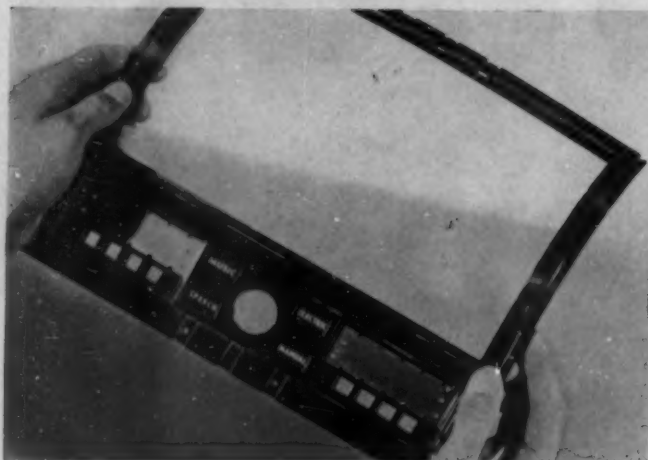
BROOKLYN, N. Y.



8



9



10



11

8. Masuron is used in making this test strip for Western Electric Co. 9. Resistance spools manufactured by the Western Electric Co. of Masuron. 10. Radio bezel of Tenite molded by American Insulator Corp. for RCA—Victor. 11. Goggles injection molded of Plastacele

and is ready for ejection in a few seconds, requiring practically no finishing.

The injection molding machines available today will see great improvements in the years to come. They all have drawbacks, and molding material of special characteristics are required for the different machines, even for the same article. This is, however, to be expected in such a new field and before long the injection molding industry should become more rationalized. It speaks well for the versatility of the cellulose acetate plastic that it has been able to comply with the many demands. It is, of course, obvious that the desired quality in the finished article alone should dictate the composition of the cellulose acetate plastic to be used, and not the peculiarity of the particular brand of injection molding machine employed. Machines must be designed of sufficient flexibility to overcome the above objections. It is wonderful to review the great variety of articles already made by the injection molding process.

1936 and 1937 has seen some of the leading automobiles equipped with molded cellulose acetate hardware and from present indications 1938 will see it on practically all cars, from steering wheel to door handle and lighter knob. We shall see our bathroom fixtures of cellulose acetate in appropriate colors and we shall soon find it as door handles in our homes. The architects and builders are discovering the new beauty and novel effects which the cellulose acetate plastics will give to their interior decoration schemes. And wallpapers can

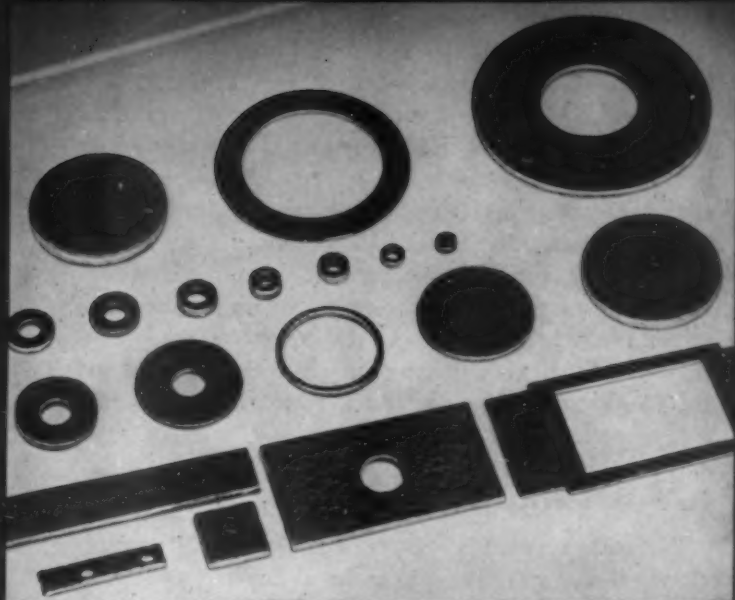
be laminated with a thin transparent cellulose acetate sheeting. Tests have shown that cellulose acetate playing cards will outlast paper cards by more than fifty times. Draw your own conclusion regarding wallpaper thus protected. Grease and fingerprints won't spoil it, and how much easier it will be to keep a room clean and fresh. Such a wallpaper should be ideal for hospitals. It will be as sanitary as a glass tiled wall without having the depressing effect which the regular "hospital atmosphere" may have on the patient. By the same token valuable documents and papers in our libraries can be protected for the coming generations.

The possibilities for cellulose acetate plastics in injection molding alone seem unlimited. Machines in the near future will be designed to mold per cycle more than ten times the present maximum capacity of a few ounces per stroke. We said that glass was a thermoplastic. If you have not seen, at least you must have heard of glass bottle blowing machines. They seem more than "human" and one machine can make more than one thousand bottles per minute. It took years of development before that stage was reached. But we shall see a similar development in injection molding equipment and technique, and it is no empty phrase to say that we are entering a plastic age, where the cellulose acetate plastic will play an increasingly important role.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

# Two New Bakelite Materials...

**BROADEN THE UTILITY OF PLASTICS**



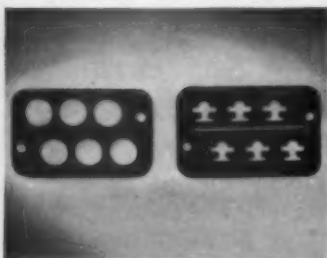
*Typical Bakelite Molding Blanks*

## BAKELITE MOLDING BLANKS

Until the development of Bakelite Molding Blanks, industry critically needed a phenolic resin material combining the ruggedness and finish of Bakelite Laminated with the moldability of Bakelite Molded. For many uses, Bakelite Molding Blanks now fulfill this requirement.

Supplied in suitable shapes punched from special resin board, and resembling "preforms" in appearance, Bakelite Molding Blanks may be employed, either alone or with other Bakelite molding materials. They have proved especially valuable in reinforcing corners, webs, bosses, lugs and other stress areas.

Write for complete details. On specific applications, Bakelite engineers will be glad to work with you in adapting Bakelite Molding Blanks to best advantage.



Insulating part molded from Bakelite Molding Blank withstands eyelet rivetting impact.



Orange juice extractor formed from Bakelite Molding Blanks and Impact Bakelite Molded.



*Jigger cap, door handle, powder box and tail-light lens of Transparent Bakelite Molded.*

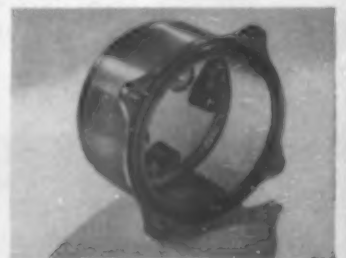
## TRANSPARENT BAKELITE MOLDED

After years of research, Bakelite Laboratories have developed the first successful transparent thermo-setting phenolic molding material. Today, *Transparent Bakelite Molded* is available in four rich, enduring colors: amber, ruby, green and tortoise-shell. With few exceptions, it may be formed in the same molds employed for general-purpose Bakelite Molded.

Various properties of Transparent Bakelite Molded are comparable to, or better than, those of standard cellulose-filled phenolic materials. It withstands exposure at 225°F. to 300°F. Its tensile, impact and flexing strengths exceed those of standard phenolic materials; and it is less hygroscopic. Its dielectric properties are excellent. Write for complete details including A.S.T.M. data.



Razor-blade sharpener housed in Transparent Bakelite Molded.



Aviation instrument case of Transparent Bakelite Molded.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N.Y.  
BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Canada West Coast: Electrical Specialty Co., Inc., 316 Eleventh Street, San Francisco, Cal.

# BAKELITE

The registered trade mark shown above distinguishes materials manufactured by Bakelite Corporation. Under the symbol "B" is the trademark sign for Bakelite, an unaltered quality. It signifies the Bakelite number of grams and four uses of Bakelite Corporation's products.

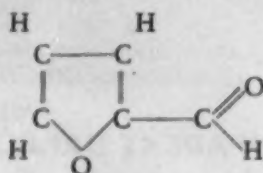
THE MATERIAL OF A THOUSAND USES

## FURFURAL AS A CHEMURGIC PRODUCT

(Continued from page 25) resin art and therefore it is now well known that furfural reacts with phenol to produce useful commercial resinous products, still the exact mechanism of this reaction, like many other resinification reactions, is not fully known. The work carried out in various plastics laboratories over the past twenty years has resulted in accumulated knowledge concerning serial progressive reactions which take place. These reactions, furthermore, may be influenced and thus varied by regulating conditions under which the reaction is carried out. The multifariousness of furfural is such that resinification is produced with materials other than phenols and on the other hand, that furfural is capable of resinification within itself has led to the production of a large variety of resins each accurately controlled to produce uniform products particularly fitted for the required function.

### Furfural unique chemically

The diverse properties of these resins may be attributed to the unique chemical structure of furfural itself.



Furfural is a heterocyclic aldehyde and the ring, connected through an ether oxygen linkage is quite stable. It will be noticed that, counting the double bonded oxygen of the aldehyde group, there are three double bonds. These are symmetrically arranged to give a conjugated system. Such a system constitutes of itself a so-called resiniphor group, and probably explains, at least in part, the ability of furfural to condense with itself to produce resinous products.

In considering the chemistry of the furfural resins there has been emphasized the aldehyde group, the unsaturated linkages and the system of conjugated double bonds in an effort to explain the most unusual and useful properties, such as plasticity and resistance to reagents, possessed by these furfural resins. We should emphasize, however, that in considering the heterocyclic character

of furfural we must consider the cyclic ring as the nucleus to which the aldehyde group is attached and in this sense the nucleus is related to the aldehyde group just as the benzene compounds are related to their original nuclei. This provides the stability that is imparted to furfural resins when reacted to their ultimate infusible form.

From another point we should consider that furfural behaves like an aromatic aldehyde and, unlike an aliphatic aldehyde, is capable of entering into substantially all the reactions that these aromatic aldehydes such as benzaldehyde are capable of. Furfural is capable of entering into more diversified reactions than are the ordinary aldehydes, due to the presence of the conjugated double bonds, entirely apart from their specific reactivity.

The heterocyclic ring exerts a stabilizing influence in so far as the maintenance of such ring structure is concerned and such ring structure if purposely ruptured and further reacted brings about the formation of a larger ring closure.

### Furfural-phenol reaction

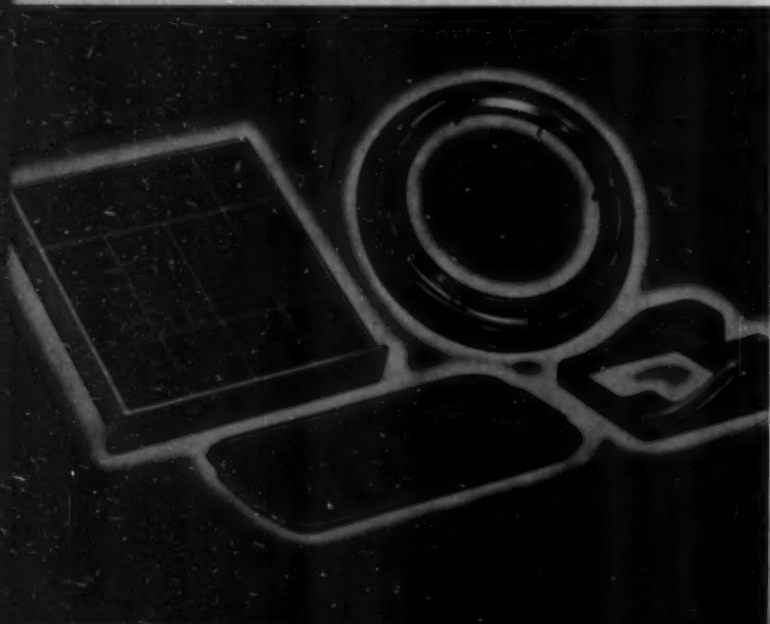
Furfural apparently reacts initially with phenols through the aldehyde group in a manner somewhat analogous to formaldehyde. The fusible resins which are first formed are probably long chains wherein the benzene and furane rings occur alternately. As the work of Staudinger, Carothers, and others has shown, chain structures have high tensile and transverse strength. Present indications are that the change from the fusible to infusible state is brought about by cross polymerization through unsaturated linkages. Since the furane ring contains two such linkages, this reaction readily takes place, and the completeness of cure in furfural-phenol resins is one of their outstanding characteristics. It seems also to produce a more rigid structure, and the furfural-phenol resins, when cured, have substantially no warpage even at high temperature.

### Exceptional chemical inertness

It will be further noticed that when once such a reaction has taken place, practically all of the active groups have become covered or used up, so that there is a minimum of vulnerable points (unsatisfied reactive groups) in the final structure. This is reflected in the extremely high chemical inertness or chemical resistance of the phenol-furfural resins.

### Outstanding compatibility

Probably one of the outstanding characteristics of the phenol-furfural resins is their "compatibility" with an exceptionally wide variety of modifying agents. This is of great importance since it permits the production of products having a wide range of physical characteristics without, in most instances, changing the chemical characteristics of the resins themselves. This compatibility would seem to result, at least in part, from the presence of both the furane and benzene ring in the molecule. The powerful solvent action of furfural itself is in part





THESE ARE BETTER WHEN MADE WITH...

**NIXON PLASTICS**

**NIXON ACETATE MOLDING POWDER**... specially compounded for injection and compression molding. Available in a wide variety of colors, tones and mottles.

**NIXONITE**, an acetate material, available in opaque and translucent sheets, rods and tubes of all colors and types, for the manufacture of lampshades, costume jewelry, accessories of all types and many other uses.

**NIXONOID**, a nitrate material, available in a full range of colors, mottles and patterns in sheets, rods and tubes. It is in use today and has been found most satisfactory for many years by makers of a host of products from buttons and buckles to bathroom ware from dresser sets to fountain pens.

**NIXON TRANSPARENT SHEETING**, the ideal material for transparent boxes, packages, displays, etc.

**NIXON NITRATION WORKS**  
NIXON NEW JERSEY

due to the furane ring. In the resin, this solvent action is manifested in "compatibility" with other materials, and in the ability to hold this resin and other materials together in such a manner as to produce a truly homogeneous combination. This results in uniformity, both of material and performance and, of course, means a minimum of strains within the structure.

#### Excellent solvent

Since furfural is an excellent solvent for practically all phenols, such a solution provides a perfectly uniform molecular distribution of the phenol and furfural molecules from the very beginning of the reaction. That is, as in all true solutions, there is a uniform distribution of both the phenol and furfural molecules throughout. Since furfural has a boiling point that is not greatly lower than phenol itself, there is no great tendency for the furfural to leave the mixture during the reaction. The reaction is therefore substantially uniform throughout the mixture, which makes it possible to produce exceptionally reproducible products.

#### The resin reaction

In the first stages of the reaction, liquid products are produced which may be used for a variety of purposes, such as impregnation, coating, laminating, etc. Further reaction produces the soluble, fusible, potentially reactive resin used in the preparation of hot molding compositions. For the reasons given above, this reaction when carried out under carefully controlled conditions can be carried up to the point where practically all of the phenol has reacted. This means that a higher proportion of the phenolic groups may be reacted in the initial stages, and thus "inactivated." The complete inactivation of the phenolic (OH) groups is of great importance if inertness or chemical resistance of the final product is to be secured, since any such groups remaining in the final product offer points of attack. For example, such groups tend to react with alkalis, and where such groups are present in the final product, such a material has relatively poor alkali resistance. In a cured furfural-phenol resin there are practically no phenolic groups that are active.

The final stages of the reaction are evidently what might be called "cross polymerization." During the first stages, long chains are apparently formed through the chemical reaction. These long chain products are resins which soften and melt at elevated temperatures.

In the case of furfural-phenol resins there is a very substantial margin between the temperatures at which the chemical reaction occurs, and the temperature at which the final "cross polymerization" occurs. Since the chemical condensation reaction produces fusible products, this permits an ample margin in the fusible range for compounding and molding and assures easy working on the rolls and excellent flow during the molding operation. It is especially advantageous for transfer or injection molding, since it provides products which remain very plastic for an appreciable time, thus permitting the material to flow into and completely fill

the mold cavity before the "cross polymerization" or setting has advanced to the point where flow is retarded or stopped.

#### Cross polymerization

"Cross polymerization," which is the final stage of the complete reaction, apparently consists of cross linkages forming between the long chain molecules at various points along their axis. As pointed out above, the double bonds in the furane ring may play a part in this change, so that the final product contains almost no chemically active groups. This "cross polymerization" results in an insoluble, infusible product, and is the "cure" of the molding compound. This cure takes place very rapidly after more or less critical temperature has been reached. Furthermore, both the rate or speed of curing, and the temperature at which it begins may be modified and to a large extent controlled by means of other chemicals acting as catalysts. It is thus possible to produce resins having an extremely rapid, or a relatively slow cure, and the compounds may thus be modified to fit the requirements of a particular molding job. For example, in molding large pieces having thick sections, sufficient time must be allowed for the material at the center of the section to become heated before the surface is cured, otherwise internal strains are set up. In pieces of thin section the cure may be extremely rapid, since only a short time is needed for the heat to penetrate the short distance to the center of the piece. This versatility of the furfural-phenol resins has made them outstanding for use where the molder does his own compounding. By simple variations of his compounding on the mixing rolls, he can produce molding powders which have high flow characteristics, or which are rapid or slow curing, or which have other special properties especially adapted to the particular object to be molded.

#### Molecular economy

Furfural has a molecular weight of 96, the molecular weight of phenol is 94. Since they react in molecular proportions, it is seen that almost equal weight proportions are used. In the reaction, one molecule of water is formed from each molecule of furfural plus phenol reacting. It is thus seen that the phenol and aldehyde are very evenly balanced in the reaction, and, furthermore, that the amount of water present during the reaction is very low. While this is advantageous in the preparation of the resin, there is another advantage: namely, that fewer molecules of the reacting materials are required to produce a given weight of resins than in the case where low molecular weight aldehydes are used. There are therefore not only fewer phenolic groups, but also fewer aldehyde groups to react to secure a given weight of resin. This results in exceptional stability of the resins.

1. October 1936 issue.
2. Method developed by Dr. Hans Winterkorn, Missouri College of Agriculture, Columbia, Mo.
3. Forest Products Laboratory paper by Bateman, Beglinger, Hoff, Sherrard and Tyner, Pittsburgh Meeting, American Chemical Society.

**Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.**

# HERE IS PROOF THAT RAYCO COTTON FLOCK IS *Superior for Molding*

Note this microphotograph of Rayco Cotton Flock. The Rayco method of production provides uniform, clean fibres because the flock is CUT NOT GROUND! Rayco Flock is unusually free from powder particles . . . which add no strength to moldings, no bulk to molding materials. Rayco fibres are grit free . . . give better bulk to plastics . . . make for better, stronger moldings with finer finish.



Custom molders will get better results from molding compounds filled with Rayco Cotton Flock. Ask your supplier to show you this.

Rayco Cotton Flock is available—at the right prices—for immediate and contract deliveries. For full details and samples write, today, to

**RAYON PROCESSING COMPANY**

86 TREMONT STREET • CENTRAL FALLS, RHODE ISLAND



# PLEXIGLAS

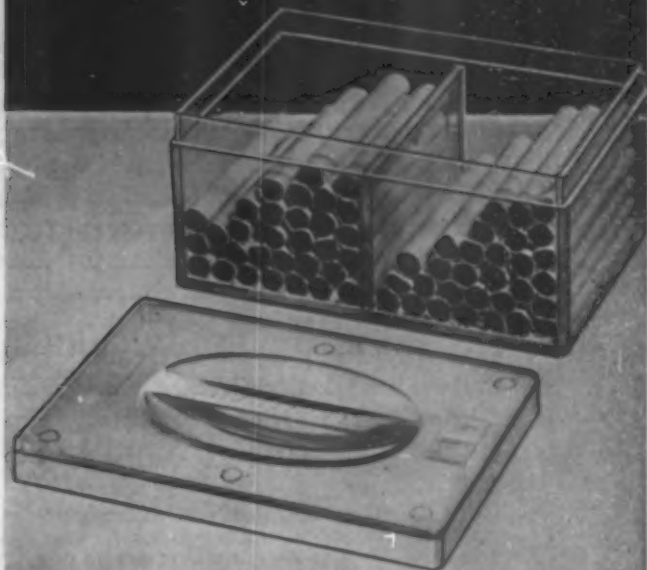
**T**HIS thermoplastic, the first solid acrylic resin to be manufactured on a commercial scale in the United States, has been on the market for over a year in the form of plane and curved sheets. Plexiglas\* is characterized by the outstanding permanent properties of perfect colorless transparency, and stability against aging and weathering.

\* Reg. U. S. Patent Office



**RÖHM & HAAS**  
*222 West Washington Square*

**Now being  
developed  
for molding—**



## CRYSTALITE

This granular acrylic thermoplastic molding material will be available in commercial quantities in the near future. The definite date of availability of Crystalite\* will be announced in one of the next issues of "Modern Plastics."

Crystalite molded objects are characterized by colorless transparency, relatively high softening point, and freedom from warpage and shrinkage.

\* Reg. U. S. Patent Office

# COMPANY, INCORPORATED

PHILADELPHIA, PA.



"Plexiglas is on display at the Metals and Plastics Bureau, International Building, Rockefeller Center, New York City."

## RUBBER-LIKE RESINS

(Continued from page 36) the butadiene polymers, however, its superior solvent resistance is practically limited to the paraffin hydrocarbons. Benzene and chlorinated solvents attack articles made from it.

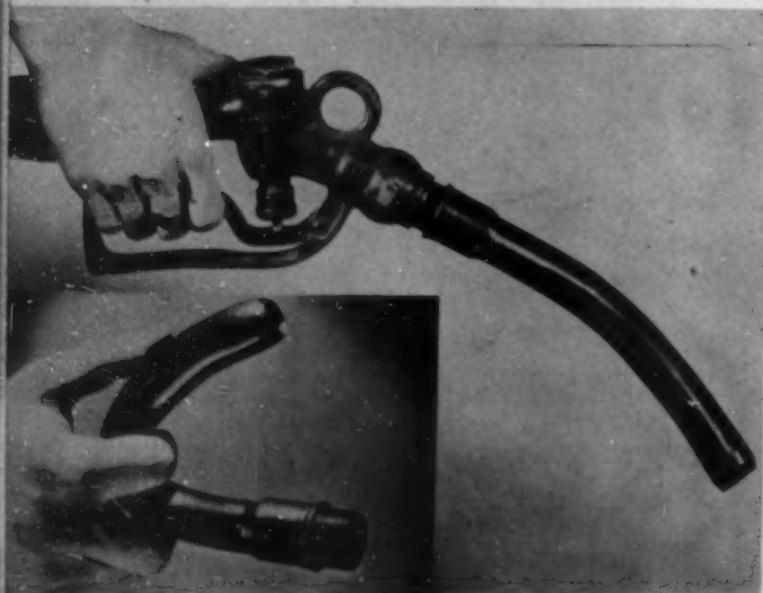
The second rubber-like resin to be considered here was the first to appear on the American market. It differs fundamentally in chemical structure from both natural rubber and the related butadiene and chloro-butadiene polymers. This product was evolved after the realization by American chemistry that "rubber-likeness" is not necessarily closely related to chemical formula and that the butadiene skeleton is often more of a hindrance than a help. Several varieties of this new product are pro-

3. Cargo hose lined with rubber-like resins is claimed to outlast non-oil-proof cargo hose by more than fifty percent.  
4. A gasoline pump hose nozzle of rubber-like resin, whose flexibility is one of its most important characteristics

3



4



duced to meet different requirements of industry.

Chemically the various types of this "native rubber" may be classed as organic polysulfide polymers, and it is interesting to note that while possessing the physical characteristics of rubber, the difference in chemical structure from that of rubber and the analogous butadiene derivatives, probably accounts for the unique resistance to both solvents and to oxidation. The resistance of the polysulfide polymers to solvent attack is not confined merely to the paraffin hydrocarbons, but includes a wide variety of the most active solvents used in industry. Moreover, manufacture of this material fortunately is carried out economically and the potentially low cost and ready availability of the raw materials make entirely possible eventual competition in price with natural rubber.

### Uses of synthetic rubber

Both major rubber-like resins have found their widest application to date in the rubber manufacturing industry. Their relationship to rubber, their behavior in manufacturing, which is quite similar to that of rubber, and the fact that the rubber manufacturing industry supplies great quantities of goods to the oil and petroleum industry, and have therefore been the most anxious to utilize the advantages of oil-proof rubbers—these three factors make this a natural circumstance. Hose, particularly, made from the polysulfide polymers, is now in use for conveying not only gasoline and fuel oils, but for gasoline-benzol blends, pure benzol, lacquer solvents and the various chlorinated solvents. Other industries using much of the present supply are the printing, automotive, aviation, textile and the plastics industries.

Of particular interest has been the development of polysulfide molding powders. In effect, this development has placed every molder of ureas and the phenolics in the position of being able to supply many types of rubber-like molded goods. Without any investment in new molding equipment, molding concerns can furnish packing rings, gaskets, washers, soap dishes, seals, diaphragms and similar products.

One important instance occurring during 1937 was the reported addition by one molder of a considerable volume of new business through his ability to supply service stations with an oil-proof gasoline pump hose nozzle.

Any extended reference to the present applications of domestic rubber-like resins would be difficult indeed and beyond the scope of this article. But the spectacular and steady increase in the tonnage of both the chloro-butadiene and the polysulfide rubbers strongly indicates the desirability of further investigation by alert technicians. Further, the extraordinarily wide applicability of the polysulfide polymers speaks well for the validity of the American-born theory—namely, that to imitate rubber chemically is not necessarily the goal of research in synthetic rubber.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

## PHENOFORM COLORS

● An interesting variety of Phenoform Colors especially produced to meet the highest requirements for molding. Also, a carefully selected group of high quality Pigment Colors developed for the plastic and related industries.



**General Dyestuff Corporation**

435 Hudson Street, New York, N. Y.



# Beetle

## WALTHAM HARMONIZES THE TIME WITH THE PLACE

● Because Beetle\* comes in a wide variety of colors, which can be chosen to harmonize with any decorative scheme, it is the ideal color material for use in combination with other material parts. Decidedly cheerful is the effect created by Waltham through the



use of Beetle in this modern electric timepiece. Unusual accuracy of construction and tolerances was achieved as the result of Beetle's adaptability in molding.

## GEM RAZOR PUTS USER'S CONVENIENCE FIRST

● Nothing puts a customer in a more favorable frame of mind toward a product than concrete evidence that the maker had his convenience in mind in designing and packaging it. Gem Razors come in a Beetle package that is pleasant to see, handle and use. It is



strong, sanitary, rust-proof and smartly appropriate to the modern hygienic bathroom interiors. Physical properties of molded Beetle make it the ideal packaging material.

## BEETLE RIDES THE AIR WAVES LIGHTLY

● Compactness and reduction of weight are two major considerations in designing buffet equipment for air service. That's why Beetle tableware was se-



lected by the United Air Lines for all of its Mainliner Planes. In addition to the pearl white set shown, orange and yellow sets also add to the attractiveness of the table service.

### BEETLE REFLECTORS FIND READY ACCEPTANCE IN LIGHTING FIELD

● The research laboratories of American Cyanamid Company developed Translucent Beetle as a material for more efficient lighting. A product of chemistry, it is now an instrument of science, meeting all specifications for reflectors on I.E.S. approved lamps and bringing to reflectors for industrial lighting new advantages such as greater strength and lighter weight.



The Chase Brass & Copper Company reflector shown here illustrates the adaptability of translucent Beetle to modern interior lighting. It is approximately one-third the weight of an identical shape in glass, is shatter-proof and greatly reduces the possibilities of breakage, both in transit and in use.

### BELMONT RADIO ADDS BEAUTY OF SIGHT TO BEAUTY OF SOUND

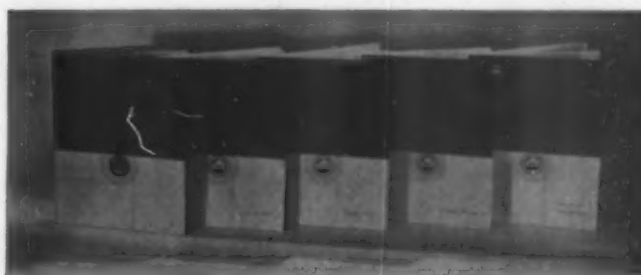
● Recognizing the undeniably powerful sales appeal in lustrous color and a damage-defying finish, Belmont Radio Corporation selected Beetle for this smartly designed set. Economy, also, influenced the choice, for Beetle housings are strong but light in



weight, can be molded in a single complete unit and require no other polishing, painting, or finishing operation.

### BEETLE BOOKLETS AVAILABLE

● These specially prepared technical booklets are available for manufacturers and molders desiring further information about Beetle. No. 1 gives information on Beetle Material for Molding; No. 2 describes the Properties of Molded Beetle; No. 3 covers many types of Applications for Molded Beetle; No. 4 gives data on Molded Beetle for Lighting Applications. These booklets and further information on Beetle Resins, Beetle Cements and Beetle Crease-proofing Compound for textiles are available to interested manufacturers on request. Extensive research facilities of the Beetle Products Division of American Cyanamid Company are at the disposal of customers for co-operation in adapting Beetle to new uses.



BEETLE PRODUCTS DIVISION OF AMERICAN CYANAMID COMPANY  
30 ROCKEFELLER PLAZA, NEW YORK, N. Y.

\*Trade-Mark of American Cyanamid Company  
applied to urea products manufactured by it.

# it's all color and in all colors

## UREA RESINS AND MOLDING COMPOUNDS

(Continued from page 42) specified an indirect reflector for floor lamps and table lamps, the principle has graduated into other fields where I.E.S. specifications are not existent. Outstanding in this respect is the development by the Steele and Johnson Company of a series of lamps incorporating either a small plastic shade or a diffusing reflector for a lamp. In each case the shade and reflector are designed to screw directly onto a standard lighting socket, thereby eliminating the need of additional fitting parts. The detail and exact dimensions to which molded urea parts can be held and produced made such a development possible. The light weight material made possible the addition of the reflector to the lamp without sacrificing the lamp's stability.

The use of urea plastics for lighting may now be seen in the home, office, factory, school, bus, automobile, street car and railroad coach—and yet the full possibilities of this material with regard to lower costs, new forms and applications have not been exploited.

From the raw material standpoint, the degree of control necessary to produce a satisfactory lighting material is of the highest order. The material must be absolutely clean and exactly suited to the molding conditions existent in any one plant. Unless the material is so suited, it may show flow lines or gas marks. Cooperation between the illuminating engineer, molder and material manufacturer is essential.

A matter of outstanding importance to everyone concerned with the production, fabrication and use of urea plastics for lighting is the question of heat. Urea moldings will withstand temperatures of 165 deg. F., but if they are exposed to temperatures exceeding this amount for any lengthy period of time, the resin will be affected

and will discolor. This is an inherent property of urea resin, and the addition of heat resistant fillers will not alter the resin's resistance.

It is important therefore for a designer or a molder to bear this limitation in mind when designing a new reflector. The open type indirect luminaire is best suited to the material, since heat is carried off of the molded surface by ventilation and reflection. The designer must be certain that he allows sufficient distances between the bulb and reflector surface to keep temperatures below the critical point. He cannot assume a reflector will be used for the purpose for which he designed it, and therefore should allow a factor of safety.

The raw material producer, the molder and the manufacturer selling plastic reflectors, should make known this limitation of the material. Any attempt to conceal or misrepresent this fundamental limitation of the urea resin will result in the loss of a very profitable and growing market. Molded urea reflectors offer enough positive advantages to offset the material's inability to withstand high temperatures.

Perhaps the third greatest development in the use of urea molding materials over the past year is that for containers and packages. Molded urea containers are not exactly new to the packaging industry, but their widespread use in new fields and greater use in old has proved the material for packaging purposes.

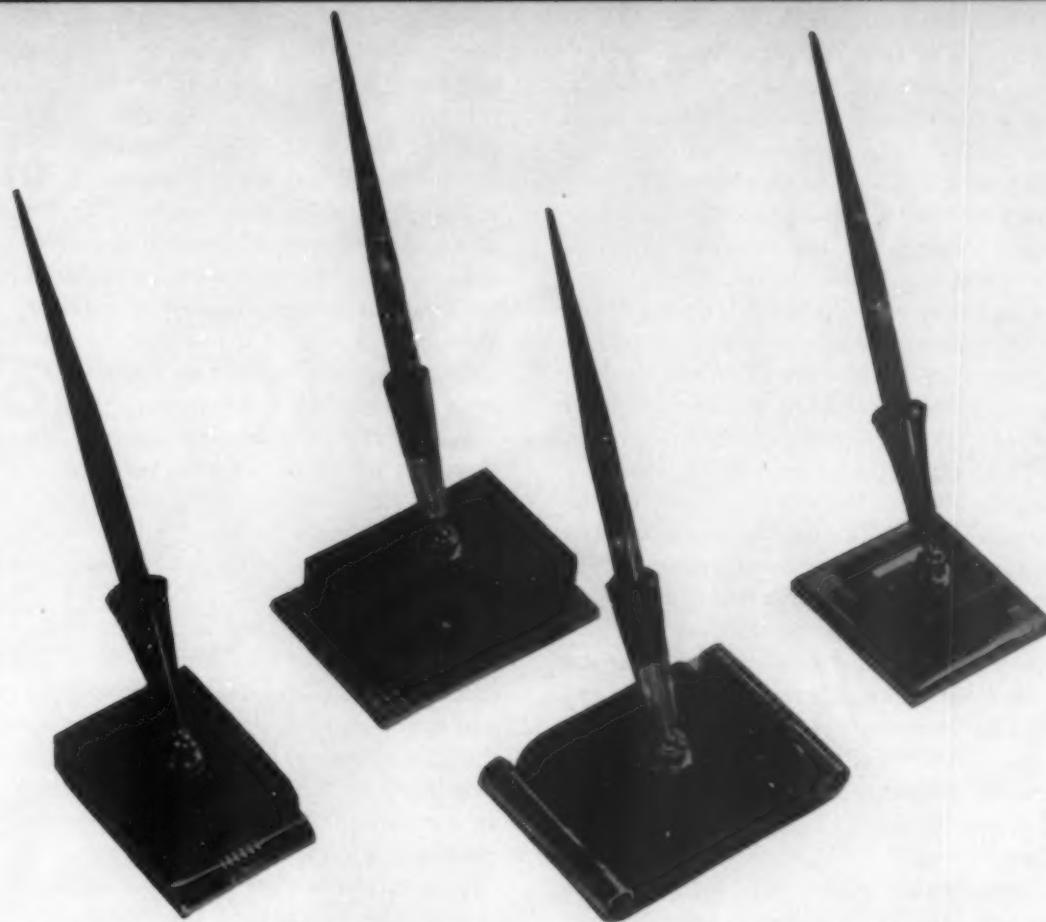
The most outstanding innovation in plastic packages was the development of a satisfactory cream jar and cosmetic container by the Colt's Patent Fire Arms Manufacturing Company. This development centered about the construction of a double shelled jar, the inner shell of which is a special material developed by this company, and the outer shell a urea or phenolic material. By this means the container obtained the virtue of strength without a corresponding increase in weight. The creation of an air chamber tended to preserve the contents and prevent the loss of moisture through evaporation; and finally, combinations of brilliant colors became available in the three piece assembly.

This development meant that cosmetics and toiletries having a high water content could be packaged in plastic containers which have unusual color and display values, and which are compact, useful items in the hands of the consumer or manufacturer. Combination kits and ensembles of varicolored ureas permitting the packaging of creams, rouge, powder and mascara in the same container were developed. Not only was this innovation of extreme importance to the manufacturers from the packaging point of view, but shipping costs were cut in half, the display value of the items was enhanced, and combination sales of logically related products were at once handy to the consumer and economical to the producer.

Another departure in the packaging field was the introduction of a practical fruit cake container by the Larsen Baking Company. This box, designed to afford a quality container for a high quality cake, served not only as a packaging item, but also as a medium of display and an article of great reuse value to the consumer. Ureas are particularly well (Continued on page 86)

Emerson developed this smart compact radio. The housing consists of three parts molded of Beetle by Associated Attleboro Mfrs., Inc. Plastics kept its weight to six pounds





## For Parker's Smartest Line of Desk Sets

### 18 Gleaming *Marblette* Bases

The Parker Pen Company, and its plastic fabricator, The Keolyn Plastics Company, unhesitatingly selected gleaming Marblette for the new line of Parker Desk Sets. For no other material—plastic or otherwise—offers the combination of desirable qualities to be found in this cast phenolic resin. Color—in every shade and tint desired! Ease of working . . . and low fabricating and finishing cost! Long life, sturdiness, sales appeal, beauty of finish!

Here, as in hundreds of other instances, Mar-

blette has justified its cost on every basis of consideration . . . in terms of cost, effect and sales! Investigate this remarkable material now. Let us recommend fabricators, in your own territory, equipped to meet your requirements.

Marblette is available in over four hundred standard shapes—rods, tubes, blocks and sheets—and in special shapes from your own or stock molds. It can be economically sawed, cut, carved, drilled, threaded, embossed, faceted and polished.

## THE MARBLETTE CORPORATION

37-21 Thirtieth Street • Long Island City, N. Y.

Telephone STillwell 4 8100

Mid-West Office: Room 15121 Merchandise Mart, Chicago, Ill.—Phone Superior 7174

Western Office: 164 La Brea Avenue, Los Angeles, California

Canadian Office: 45 Richmond Street W. Toronto

(Continued from page 84) adapted to the problem of packaging dry foods, since the material is inert, and does not impart either odor or taste to the contents.

The older and better known uses for urea plastics in other fields are ever increasing. Such applications as closures, watch and jewelry containers, razor boxes, cutlery set packages and manicure ensembles are really quite well known now to the package designer and merchandise manager. They know the value of display, of color and of inert material. They know also that their packages using such material will not deteriorate in the retail store from continued handling or display. They are slowly beginning to depart from their preconceived notions of forms and shapes caused by the limitations of other products, and are developing entirely new shapes, made possible by a better knowledge of urea plastics.

In the market for buttons, buckles and slides, the demand for urea parts is definitely on the increase. The ability of this type material to withstand constant washing without the danger of bleeding or fading colors has made the use of urea parts with fine clothing a natural one. This demand has not only developed for slides and buttons, but also for findings, costume jewelry, etc. Color developments in these fields have been definitely toward more translucent and delicate tints.

The old faithfuls, tableware and premiums, are carrying on with renewed vigor. Tableware particularly has felt the demand stimulated by trailers and airplanes for light weight, durable dishes. As for premiums, General Foods and Old Dutch Cleanser among others distributed several million items to the consumer in the form of cereal bowls and wall brackets with a considerable success in the sale of their products.

In concluding this section on urea molding materials, we should like to refer again to our opening paragraph, wherein we alluded to the unique properties of urea resins and their use by industries. It is our feeling that these properties have not as yet been fully exploited, nor can we gage accurately where they will eventually carry the development and uses of ureas. We believe, how-

ever, that it is to the advantage of all groups concerned to broaden and deepen the markets for urea molding compounds in those applications for which they are best suited. We believe it to be the primary function of the material suppliers to make commercially practical the exploitation of these unique properties, thereby creating a broader and more economically stable basis on which the molders may operate. Our mission should be sound development, research and study of the material and its applications to ensure continued improvement. Competition among producers is secondary to this program, and should, as it has over the past years, act as a spur for the improvement of materials and technique to meet new demands and new uses.

We believe our foregoing discussion of urea molding materials will have given the reader some knowledge of the properties of the resin itself. Our discussion of uses of urea resin for other purposes will therefore be brief, dealing with its use for laminated products, textile applications and paint.

The use of laminated ureas expanded rapidly during the past year, due considerably to the revived building industry and general improvements in the raw materials and laminating technique. Some of the earlier treating difficulties, such as insufficient wet strength of the paper, brittleness of the coated paper and a lack of flexibility in the curing cycle have been overcome by recent improvements in the materials.

In general there are two types of urea laminated materials—the opaque and the translucent. The opaque sheet consists of an opaque core or center section, coated with a urea surface. This core may be plywood, asbestos, a laminated phenolic material or a combination of phenols and wood. The surface of urea is applied to afford a range of stable and brilliant colors. The opaque product is probably the better known of the two, and finds extensive use for bathroom wall coverings, table tops, bars, kitchen drain boards, window sills, etc., where a colorful and easily cleaned finish is desired.

The introduction of translu- (Continued on page 88)

Flexible, translucent sheets of Beetle laminated by Formica Insulation Co.



Novelty eye-bath in color, molded of Plaskon by Colt's Patent Fire Arms Co.

# Bakelite Molded...

SPECIAL TYPES FOR SPECIAL SERVICES



Governor disc, hydrometer body, magneto leadout and radio crystal holder of special Bakelite Materials. Meter case, at top, of General Purpose Bakelite Molded.

**B**ECAUSE of its high performance in countless applications, the original, or General Purpose, type of Bakelite Molded has become a recognized standard of plastic materials. Its value lies in ready moldability plus an unusual combination of useful characteristics.

Today, in addition to *General Purpose* Bakelite Molded, there are numerous special types adapted to special, difficult services. In each, characteristic advantages of the standard material are retained, and one special property is emphasized.

For example, *High Impact* Bakelite Molded possesses more than 14 times the impact strength of the General Purpose type; and *Chemical Resistant* Bakelite

Molded withstands a 10% sulphuric acid test with dimensional reflux of only  $\frac{1}{8}\%$ , compared with 9% for the General Purpose Bakelite Molded.

Also, *High Heat Resistant* Bakelite Molded stands up at 500°F., as against 300°F. for the General Purpose type; and *Low Loss* Bakelite Molded possesses a loss-factor at 1,000,000 cycles only 14% of the value of the General Purpose type.

Due to this versatility, we urge you to consider Bakelite Molded wherever difficult problems are encountered in designing. We will be glad to recommend appropriate types.

Useful information on other important Bakelite Materials is given on pages 000 and 000 of this publication.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N. Y.  
BAKELITE CORPORATION OF CANADA, LTD., 163 Dufferin Street, Toronto, Ont.

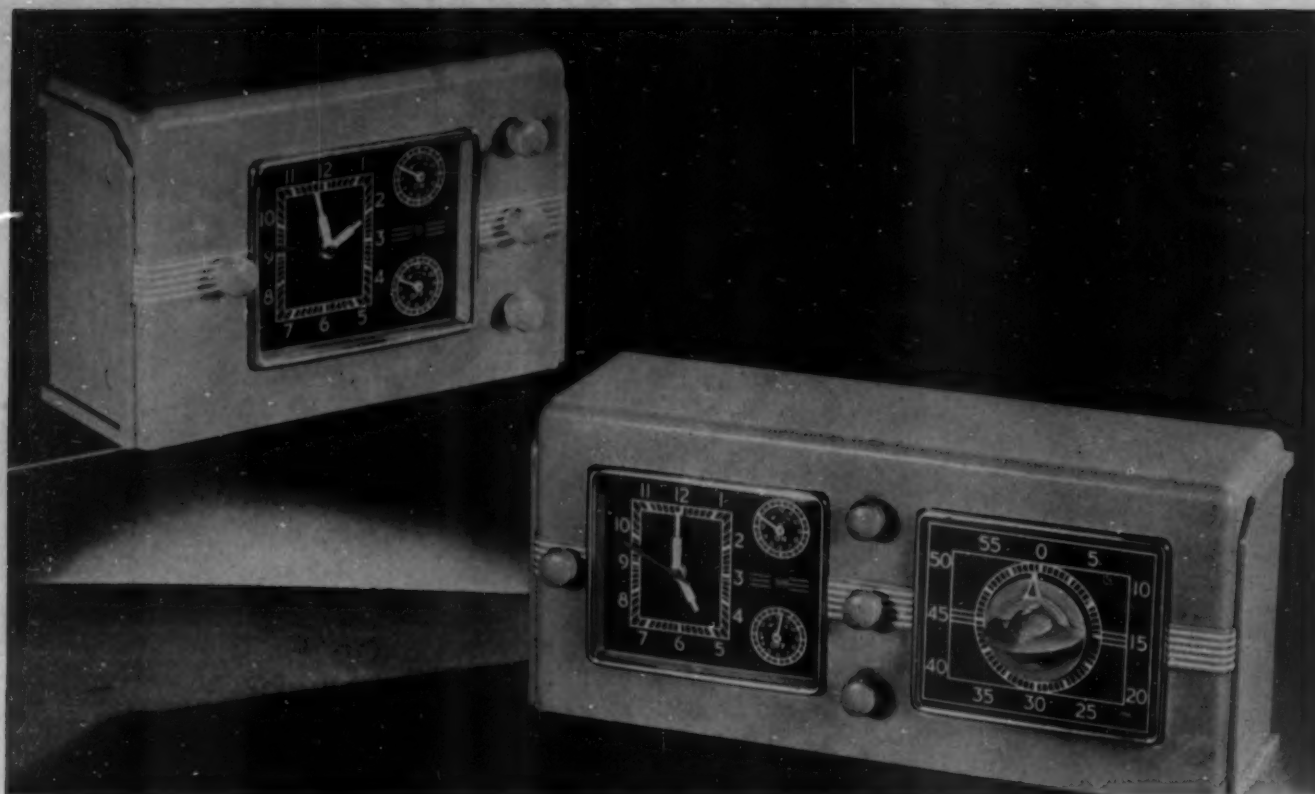
West Coast: Electrical Specialty Co., Inc., 316 Eleventh Street, San Francisco, Cal.

## BAKELITE

The registered trade mark shown above distinguishes materials manufactured by Bakelite Corporation. Under the capital "B" is the Bakelite logo, a stylized "B" inside a circle. The registered sign for Bakelite, an unaltered quality. It indicates the close relation of present and future uses of Bakelite Corporation's products.



THE MATERIAL OF A THOUSAND USES



Westinghouse range timers which indicate the decorative and functional value of molded ureas where cleanliness in service is a selling advantage

(Continued from page 86) cent laminated urea panels was probably the greatest development in this field during the past year. This material met a very great need in the field of lighting for a panel material, light in weight and flexible, which could be used for cove or trough illumination. The durable qualities of this material both in form and color permit the extension of thermosetting plastics into a completely new market.

The most important point with regard to this new product is that the laminator by varying the opacity of the resin may obtain sheets in any thickness having almost any desired optical properties. Extreme translucency or opacity may be obtained in various stable and light fast colors.

Inks compatible with urea resins were also developed in the last year. By printing with these inks on a thin sheet of absorbent paper and pressing this paper as a subsurface sheet, translucent signs may be obtained in any desired combination of colors. Not only are the colors light fast, but since the printing is below the surface, it is as permanent as the sheet itself.

In the textile fields, the use of urea resins is rapidly on the increase. Creaseproof fabrics, although not new, are just becoming known to the general public, and the number of textile companies in the field exploiting the properties of this resin is practically double that of a year ago.

Creaseproofing is accomplished by impregnating a fabric with an aqueous solution of the unpolymersized resin. The fabric is then passed through squeeze rolls,

dried, and then treated by heat for a few minutes at temperatures ranging from 280 deg. F. to 300 deg. F. The heat treatment polymerizes the resin and renders it insoluble. Properly treated, the fabric has the same hand as the untreated material, and will remain wrinkle-proof for the life of the fabric. Velvet, linen, cotton and spun rayon materials, rendered crush resistant with urea resins, may now be purchased at any of the leading department stores.

Permanent finishes, obtained with urea resins, made their appearance during the past year and met with a ready welcome from the trade and the consumer. In this application, a highly reacted resin is applied either in an aqueous solution or emulsion. A very small percentage of resin greatly improves the fabric with regard to color brilliance, body, tensile strength, and shrinkage. Since the resin is already highly polymerized much less heat treating is required than for creaseproofing.

During the past year alkylated urea resins, soluble in organic solvents, were sold in large quantities for the first time. Their chief use was as a baking enamel, consisting of the modified resin, a white pigment and a suitable plasticizer. The white film obtained is hard even while hot; it is flexible and resists yellowing by heat or sunlight much better than similar films obtained with alkyl resins.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section

DOW

## PLASTIC MATERIALS

AND RAW MATERIALS FOR THE PLASTIC AND RESIN INDUSTRIES

### ETHOCEL\* DOW ETHYL CELLULOSE

Ethyl cellulose is a comparatively new and extremely versatile industrial raw material. Its unusual combination of properties indicates its utility for improving present applications of cellulose derivatives and for developing many new and commercially important uses. Dow Ethyl Cellulose is available in several ranges of ethoxyl content and intrinsic viscosity under the trade name, ETHOCEL.

#### PROPERTIES:

Readily soluble in low-cost solvents and unusual tolerance for petroleum thinners.

Compatible with a wide variety of plasticizers, resins, and drying oils, as well as with nitrocellulose.

Due to its low specific gravity, it has 45% more film forming volume per pound than nitrocellulose, 18% more than cellulose acetate.

Low flammability . . . Colorless, odorless, tasteless, and non-toxic . . . Imparts toughness and flexibility to coatings . . . Retains flexibility at low temperatures . . . Resists strong alkalis and dilute acids . . . Stable to heat at

ordinary molding or baking temperatures . . . Is not discolored by light or aging . . . Readily wets and disperses pigments.

Uses—Flexible lacquers for wood, metals, paper, textiles and rubber.

Increasing resin content and flexibility of nitrocellulose lacquers.

Production of varnishes and sealers of decreased drying time and increased flexibility.

Flexible cable coatings of high insulating value and low flammability.

Lacquer emulsions for fabric and paper coatings.

Printing inks of improved drying time and freedom from offset.

Pigment dispersion for lacquers, enamels and printing inks.

Plastics for injection and compression molding.

Artificial silk and staple fibers.

Transparent wrapping or insulating foil.

Production of wax and resin compositions of increased toughness and melting point.

Preparation of hot melt coatings for application without use of volatile solvent.

### STYRENE

Styrene is a clear colorless liquid which polymerizes under the influence of heat to polystyrene, a clear transparent thermoplastic resin. This property and the dielectric strength of the polymer has long made styrene an interesting chemical to the electrical and plastic industries. Through Dow research and resources, liquid styrene of high purity is now being offered as an industrial raw material.

#### PROPERTIES:

**LIQUID MONOMERIC STYRENE**—Several grades of Dow STYRENE are available, all above 95% styrene content. The properties listed are those of a very pure grade of styrene. Styrene, monomeric . . . 99.9%  
Boiling Range, at 100 mm. Hg. . . 81-82°C.  
Freezing Point . . . -30.8°C.  
Refractive Index, at 25°C. . . 1.5438  
Specific gravity, at 25/25°C. . . 0.905  
As supplied for industrial use, styrene contains an inhibitor which retards polymerization.

**POLYSTYRENE**—Different viscosity types of pure polymerized styrene molding powder are produced. The properties listed below are those of one of the polymers which has wide utility.

Styrene, polymeric, not less than . . . 97%  
Specific gravity . . . 1.05-1.06  
Viscosity of 10% solution

in toluene . . . 20 to 30 cps.  
Molecular weight . . . 50,000 to 70,000  
Softening point . . . 105-115°C.

Uses—Liquid styrene is readily polymerized to a wide variety of solid forms for electrical and optical uses. Polystyrene can be manufactured as free flowing particles. This form is especially suited to the production of styrene molding powders for injection molding of a variety of shapes for electrical and decorative uses. Polystyrene also may be formulated into insulating and coating compositions. Research is disclosing many additional uses.

### VINYL CHLORIDE

An increasingly interesting raw material  
to the resin industry.

Boiling Range . . . (-13.5c)—(-14.0c)  
Density . . . . .91 at 20/20°C. (49 lbs. abs. pressure)  
Less than . . . . .1% acetylene

### DOW CHEMICALS OF INTEREST TO PLASTIC AND RESIN MANUFACTURERS

ACETANILID

ACETIC ANHYDRIDE

ANILINE

CAMPHOR  
MONOBROMATED

CARBON BISULPHIDE

CARBON TETRACHLORIDE

ETHYL CHLORIDE

ETHYLENE DICHLORIDE

HEXACHLOROBENZENE

HEXACHLORETHANE

ORGANIC SOLVENTS

ORTHOCRESOTINIC ACID

ORTHOCYCLOHEXYLPHENOL

PARACYCLOHEXYLPHENOL

PARA TERTIARY BUTYL  
PHENOL

PHENOL

PHOSPHORUS OXYCHLORIDE

SALICYLIC ACID

TRIPHENYL PHOSPHATE AND  
MIXED PHOSPHATES (DOW  
PLASTICIZERS No. 1 to 9)

### THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

Branch Sales Offices: 30 Rockefeller Plaza, New York City—Second and Madison Streets, St. Louis—135 South La Salle Street, Chicago

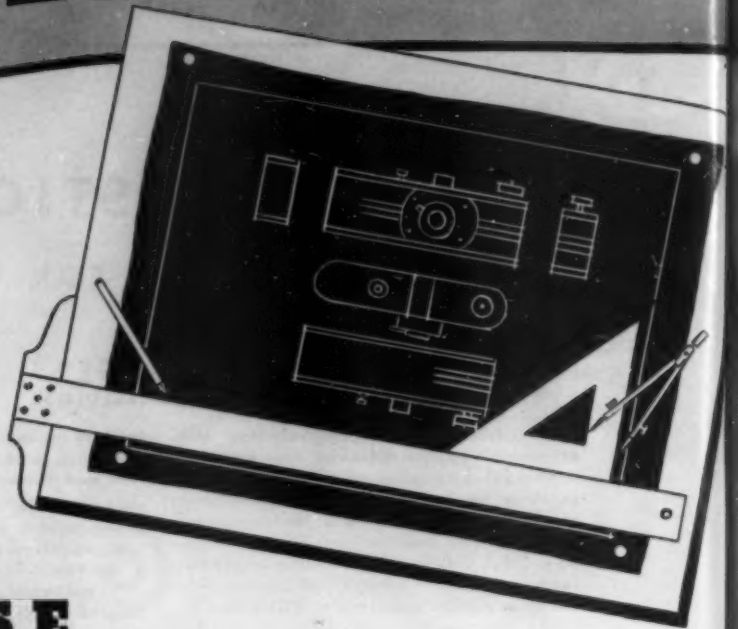
\*Registered U. S. Patent Office

OCTOBER 1937

89

# CONVERTING BLUEPRINTS

Durez improves on older, conventional raw materials... makes formerly impossible products possible... makes new, revolutionary designs practicable. More and more manufacturers are creating new products, redesigning old ones and establishing new sales records by capitalizing on the many advantages possible with Durez.



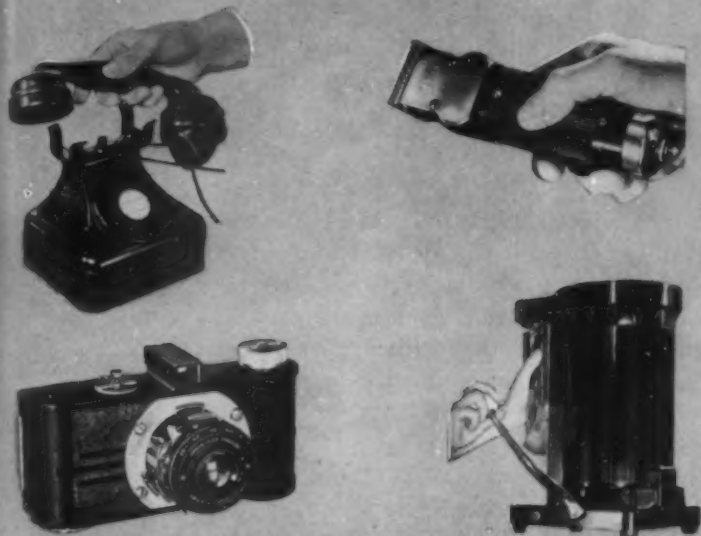
## BECAUSE

**DUREZ HAS UNLIMITED DESIGN POSSIBILITIES.** Last year's Silvertone compact with molded Durez cabinet won first award in the Modern Plastics' competition for its beautiful functional design. The cabinet of Sears Roebuck's new 1938 "Coronet" model is again molded of Durez. Telechron found Durez answered the question of how to secure economy in production... with rare beauty in appearance. Durez offers almost unlimited sculptural possibilities for housings, novelties and distinctive packages. Grooves, ribs, threads can be molded in.

**DUREZ HAS A PERMANENTLY SLEEK AND COLORFUL SURFACE FINISH.** Countless packages owe their rich "quality" appearance to Durez. Door knobs, closures, trays and housings are made of Durez because no amount of handling or abuse can make them chip, crack or dull. Durez is specified in many industrial applications because steam, caustics, solvents, mild acids and alkalis cannot pit or bleed the surface. Products made of Durez will never warp or peel, the finish can never wear off, because it goes all the way through... is not just applied.



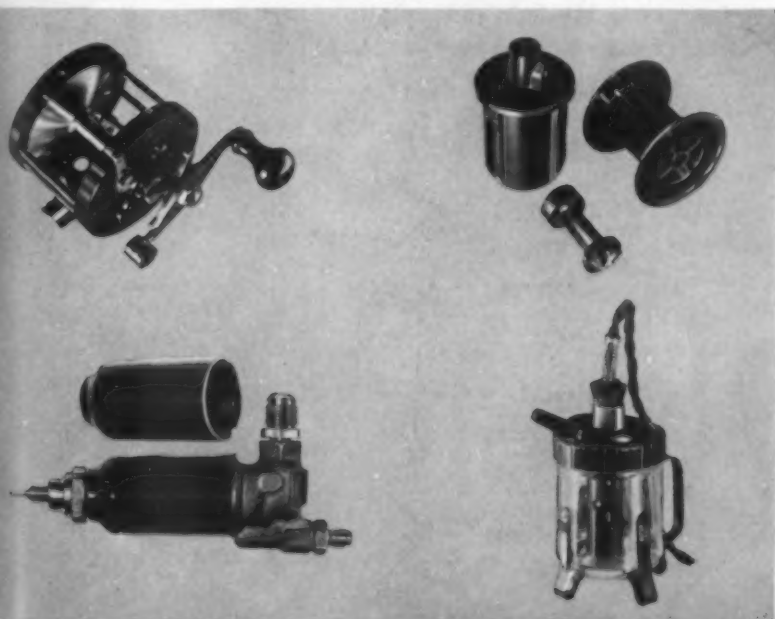
# S INTO SALES SUCCESSES



**DUREZ IS STRONG AND DURABLE, YET LIGHT IN WEIGHT.** Look at your telephone...lift it, then just try to break it. Durez instrument cases are used for airplanes—and each of the four mounting lugs must withstand a breaking-pull test of 175 pounds. Heater housings, binoculars, chair arms and cameras are molded of Durez. Properly designed Durez cases and housings are unbelievably strong for their weight.



**DUREZ HAS GREAT DIELECTRIC STRENGTH.** (Up to 1000 volts per mil.) Wires and connections can be molded right in the housing, Durez itself supplying necessary insulation. Electrical parts made with Durez have good arc resistance, and can be used for high-tension ignition service. Distributor heads, motor housings, sockets, switchboards and push buttons are made of Durez.



**DUREZ IS INERT TO CHEMICALS, IS UNAFFECTED BY WATER, HEAT AND STEAM.** The rayon industry uses Durez to make spools, frames and a host of other parts that must be chemically inert. Marine hardware, electrical fittings and fishing-reel housings are made of Durez to withstand the corrosive action of salt water. Durez is the only plastic that could remain immersed in the boiling, medicinal fluids of this vaporizer.

**DUREZ IS FORMED AND FINISHED IN ONE OPERATION.** Durez products come out of the mold complete with lugs, inserts, flutes, trade-marks, decorations and the final surface finish. Only slight buffing to remove fins is required. Durez products vary in size from a vest-pocket pillbox to the huge case of a complicated statistical machine. They are simple as a cap for a toothpaste tube, complex as an entire camera, complete except for shutter and lens.

It is the function of the Durez organization to assist manufacturers in determining the practical application of Durez molding compounds to their products. For further data consult your custom molder or write to us for descriptive literature and the advice of our technical staff. General Plastics, Inc., 710 Walck Road, North Tonawanda, N. Y.



Free on request, complete booklet of the many applications, uses and properties of Durez molding compounds.

## DUREZ

### MOLDING COMPOUNDS

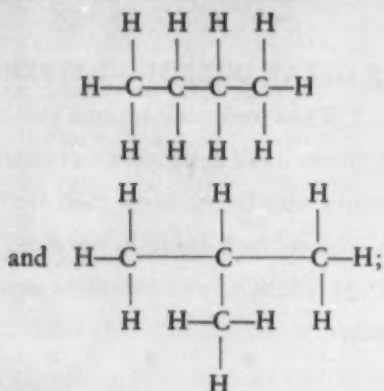
## A MOLDER'S ORGANIC CHEMISTRY

(Continued from page 10) called homologs of each other.

The first of such homologous series consists of the Paraffins, so-called because they occur mainly in petroleum and its companion gas. Note that, building on  $\text{CH}_4$  as a foundation formula, each new compound is arrived at by adding  $\text{CH}_2$ .

Methane  $\text{CH}_4$   
Ethane  $\text{C}_2\text{H}_6$   
Propane  $\text{C}_3\text{H}_8$   
Butane  $\text{C}_4\text{H}_{10}$   
Pentane  $\text{C}_5\text{H}_{12}$   
Hexane  $\text{C}_6\text{H}_{14}$   
Heptane  $\text{C}_7\text{H}_{16}$   
Octane  $\text{C}_8\text{H}_{18}$   
Nonane  $\text{C}_9\text{H}_{20}$

This series brings out very nicely what is meant by isomers. There is only one way to draw a picture of methane, C with four arms and an H on the end of each. So with ethane and propane. However, two arrangements of molecules can be made of butane,

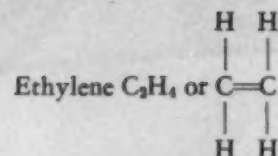


hence there are two isomers known, three of pentane, and from there up the same basic formula lends itself to more and more diagrammatic variations which are proved by the existence of distinct products.

We have here the first lesson in the new vocabulary, counting from one to nine. The numbers go right on up through twenty and more but as tourists we can't be bothered. "ANE" is the general formula. The radical we get out of this is  $\text{CH}_3$ , Methyl;  $\text{C}_2\text{H}_5$  or  $\text{CH}_3\text{CH}_2$ , Ethyl;  $\text{C}_3\text{H}_7$  or  $\text{CH}_3\text{CH}_2\text{CH}_2$ , etc. See how simply we get alcohols by adding OH to these radicals.

Methyl Alcohol  $\text{CH}_3\text{OH}$   
Ethyl Alcohol  $\text{C}_2\text{H}_5\text{OH}$   
Propyl Alcohol  $\text{C}_3\text{H}_7\text{OH}$

Still going bravely forward the mythical planner lays out the unsaturated Ethylene Series—called by their intimates the Olefins. The compounds in this series have two less hydrogens than the corresponding saturated hydrocarbons, the Paraffins. They have never captured the number one of this series, Methylene, alone, so they hold it for combination names. Ethylene is  $\text{C}_2\text{H}_4$  and again we run up by steps of adding  $\text{CH}_2$  through Propylene, Butylene and, now the poetical touch, Amylene for five instead of Pentylene.



Propylene  $\text{C}_3\text{H}_6$   
Butylene  $\text{C}_4\text{H}_8$   
Amylene  $\text{C}_5\text{H}_{10}$   
Hexylene  $\text{C}_6\text{H}_{12}$   
Heptylene  $\text{C}_7\text{H}_{14}$   
Octylene  $\text{C}_8\text{H}_{16}$

If we start with ethylene arranged  $\text{CH}_2=\text{CH}_2$ , remove the right hand H, we have  $\text{CH}_2=\text{CH}$ , the vinyl radical. Here again life is not so simple as it sounds because vinyl compounds often start from acetylene and have to be carefully guided lest they gather unwanted friends.

Our next group is not so good. Acetylene,  $\text{C}_2\text{H}_2$  or  $\text{H}-\text{C}\equiv\text{C}-\text{H}$ , is followed by Allylene  $\text{C}_3\text{H}_4$ , again by adding  $\text{CH}_2$ , and Crotonylene  $\text{C}_4\text{H}_6$ . The less said, the better off we are, because we had a fine system started and now it's shot to pieces. Just remember Acetylene.

With a little of this basic picture behind us let's look at those radicals again. All those that have one loose hand waiting for chance visitors, univalent groups, are called alkyls (or alcohol radicals). They are derived from the methane series and distinctive names are formed by changing ane to yl, thus:

|           |  |
|-----------|--|
| Methyl    | $\text{CH}_3$  |
| Ethyl     | $\text{C}_2\text{H}_5$ or $\text{CH}_3\text{CH}_2$                       |
| Propyl    | $\text{C}_3\text{H}_7$ or $\text{CH}_3\text{CH}_2\text{CH}_2$            |
| Isopropyl | $\text{C}_3\text{H}_7$ or $(\text{CH}_3)_2\text{CH}$                     |
| Butyl     | $\text{C}_4\text{H}_9$ or $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2$ |
| Isobutyl  | $\text{C}_4\text{H}_9$ or $(\text{CH}_3)_2\text{CHCH}_2$                 |

Those in the second series have two loose hands looking for trouble, bivalent, and are called Alkylenes.

Other radicals we will meet are the following:

Hydroxyl  $-\text{O}-\text{H}$

Carbonyl  $>\text{C}=\text{O}$

Carboxyl  $-\text{C} \begin{array}{l} \nearrow \text{O} \\ \searrow \text{O}-\text{H} \end{array}$

Cyanogen  $-\text{C}\equiv\text{N}$

Acetyl  $\begin{array}{c} \text{H} \\ | \\ -\text{C}-\text{C}-\text{H} \\ || \quad | \\ \text{O} \quad \text{H} \end{array}$

Aldehyde  $\text{I}-\text{C} \begin{array}{l} \nearrow \text{H} \\ \searrow \text{O} \end{array}$

Amino  $-\text{N} \begin{array}{l} \nearrow \text{H} \\ \searrow \text{H} \end{array}$

Nitro  $-\text{N} \begin{array}{l} \nearrow \text{O} \\ \searrow \text{O} \end{array}$

(Continued on page 94)



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## A MOLDER'S ORGANIC CHEMISTRY

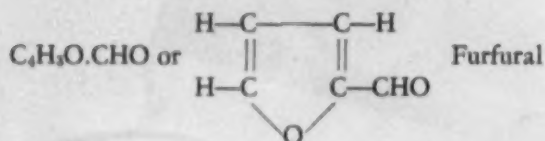
(Continued from page 92)

Ethers will be raising their heads here and there, so please know that officially an ether is a radical on each side of an oxygen atom, quite a chummy arrangement that brings out some nice names. For instance,  $\text{CH}_3\text{—O—CH}_3$  is dimethyl ether, and  $\text{CH}_3\text{—O—C}_2\text{H}_5$  is methyl ethyl ether. The ether which you inhale just before the appendix comes out is diethyl ether, just a bit of information along the way.

Aldehydes are another group whose name comes up in headlines in this type of literature. The general formula

is  $\text{R—C}\begin{array}{l} \text{H} \\ \text{O} \end{array}$ , R standing for one of our friends, the radicals.

|                             |              |
|-----------------------------|--------------|
| $\text{H—CHO}$              | Formaldehyde |
| $\text{CH}_3\text{—CHO}$    | Acetaldehyde |
| $\text{CH}_2\text{=CH—CHO}$ | Acrolein     |



Formaldehyde is, of course, the most widely known, its popularity ranging from embalming fluid to plastics, if these two may be considered opposite ends of a scale, a matter for acrimonious argument at times. A very influential school of thought holds them to be closely akin. Incidentally formaldehyde is supposed to occur in those plant cells which contain the green coloring matter chlorophyll. An aqueous solution of 40 percent formaldehyde is called formalin, and when you evaporate the water you get a colorless powder called paraform which is probably a several man gang,  $(\text{CH}_2\text{O})_n$  where n equals some whole number. If it is  $(\text{CH}_2\text{O})_3$  it is called trioxymethylene.

This transition of formaldehyde has been gone into in some detail because it illustrates polymerization—a basic action in plastics. Polymerization means the change of some simple substance into another of the same percentage composition but having a molecular weight equal to several multiples of the parent substance. It is a ganging up of several identical molecules with the resulting product quite different from the original. Phenolic resins polymerize under heat and pressure, and no longer are affected by heat and pressure in the same way.

The chemists have a good, logical, physical picture of the simpler compounds and can prove, as we said before, that the OH radical is south, south by east of the X radical. When it comes to the arrangement of the atoms in such a polymer as we finally get in the polymerization of phenol-aldehyde resins the doctors have their field day. They cover page after page with pictures and argue learnedly. We, however, will consider the stage of final polymerization as a closed room and will merely

stand at the door and mention the individuals by name as they enter. What they arrange among themselves after they get inside can be told by those who know.

Ketones are another family group formed with CO as the connecting link and a radical on each side  $\text{R—C—R}$ .



The series runs as follows:

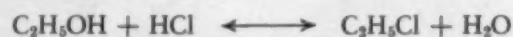
Dimethyl Ketone or Acetone  $(\text{CH}_3)_2\text{CO}$   
Diethyl Ketone  $(\text{C}_2\text{H}_5)_2\text{CO}$   
Dipropyl Ketone  $(\text{C}_3\text{H}_7)_2\text{CO}$

Fatty Acids, so called because many of the higher members occur in a combined state in natural fats, and resemble fats in physical properties, are a distinct series.

The formula is based on the carboxyl group,  $\text{—C}\begin{array}{l} \text{O} \\ \text{OH} \end{array}$ .

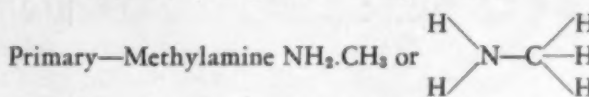
Formic Acid  $\text{CH}_2\text{O}_2$  or  $\text{H.CO.OH}$  Butyric— $\text{C}_4\text{H}_8\text{O}_2$   
Acetic Acid  $\text{C}_2\text{H}_4\text{O}_2$  or  $\text{CH}_3.\text{CO.OH}$  Valeric— $\text{C}_5\text{H}_{10}\text{O}_2$   
Propionic Acid  $\text{C}_3\text{H}_4\text{O}_2$  or  $\text{CH}_3.\text{CH}_2.\text{CO.OH}$

Esters, or alkyl salts, are the result of the reaction between alcohols and either organic or inorganic acids. Just remove the H from the acid and replace with the organic radical.



This class of compounds is important as the source of many of the present commercial resins, a way station on the road to final polymerization. The word crops up frequently later.

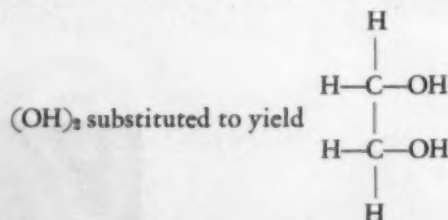
Amines come from substituting for one or more hydrogen atoms of ammonia ( $\text{NH}_3$ ) one or more of the alkyl groups. They are divided into three groups depending on the number of hydrogen atoms displaced.



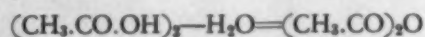
Secondary—Dimethylamine  $\text{NH}(\text{CH}_3)_2$

Tertiary—Trimethylamine  $\text{N}(\text{CH}_3)_3$

Glycols are next and they are not so nice. Officially they are dihydroxy derivatives of the paraffins. Ethylene glycol,  $\text{C}_2\text{H}_4(\text{OH})_2$ , shows  $\text{H}_2$  off Ethane ( $\text{C}_2\text{H}_6$ ) and



Anhydrides appear when certain combinations are effected and may be regarded as oxides of radicals with water squeezed out on the side. Two molecules of a monobasic fatty acid, less one of water, gets the same result. For example, acetic acid yields acetyl oxide or acetic anhydride.



(Continued on page 96)



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OCTOBER 1937

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## A MOLDER'S ORGANIC CHEMISTRY

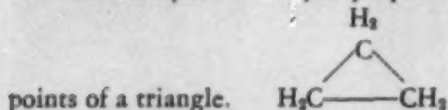
(Continued from page 94)

All of these compounds so far considered are really based on methane and can be regarded as derivatives of methane, for example:

- $C_2H_6$  or  $CH_3(CH_3)$  Methyl Methane  
 $C_3H_8$  or  $CH_3(CH_2)CH_3$  Dimethyl Methane  
 $C_2H_4$  or  $CH_3.CH_3$  Methine Methane

The methane group are also called open chain compounds, presumably built like a centipede; there is also a group classed as closed chain compounds, the basic picture of which forms a ring. The simplest members are the saturated hydrocarbons which are isomeric with the olefins.

1. Trimethylene or cyclopropane— $(CH_2)_3$  on the

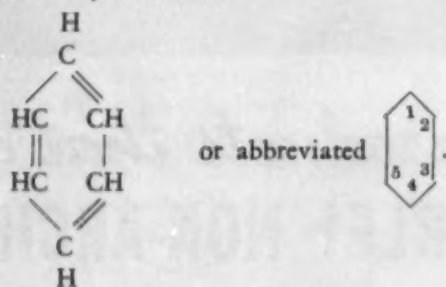


2. Tetramethylene— $(CH_2)_4$  on the points of a square.

3. Pentamethylene— $(CH_2)_5$  on the points of a pentagon.

4. Hexamethylene— $(CH_2)_6$  on the points of a hexagon.

There is another distinctive group called the aromatic series, which is based on its simplest member, benzene  $C_6H_6$ , which may be written



The positions are numbered for the purpose of reference to substituted groups.

In the benzene nucleus, one or more of the H's can be removed and one or more other radicals or elements placed in their position. If one is replaced we have the mono derivatives, two, the di derivatives, tri derivatives and so on.

The alkyl substituted benzene series, similar to methane, is as follows.

- Benzene  $C_6H_6$   
 Toluene  $C_6H_5CH_3$   
 Xylene  $C_6H_4(CH_3)_2$   
 Ethylbenzene  $C_6H_5(C_2H_5)$

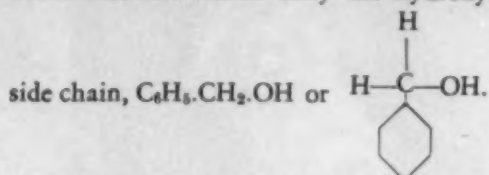
Further we have

- $C_6H_5.CH:CH_2$  Styrene or phenyl-ethylene  
 $C_6H_5.CC\equiv H$  Phenyl-acetylene  
 $C_6H_5.NO_2$  Nitro-benzene  
 $C_6H_4(NO_2)_2$  Dinitro-benzene  
 $CH_3.C_6H_4.NO_2$  Nitro-Toluene

The derivatives of benzene carrying hydroxyl groups are usually divided into two groups, the phenols, which contain the hydroxyl group or groups directly attached

to the benzene nucleus,  $C_6H_5OH$  or

aromatic alcohols which carry the hydroxyl radical in a



When two strangers join the family the physical properties of the product frequently differ depending on where they hook on to the original ring. If the strangers hang in adjacent positions the compound gets the prefix ortho, in numbers one and three positions -meta, numbers one and four -para. Hence, we can have by adding  $(CO_2H)_2$ , 1 ortho 2 dicarboxylic acid, 1 meta 3 dicarboxylic acid or 1 para 4 dicarboxylic acid depending on the position occupied.

The phenols have the standard nomenclature of mono-, di-, tri- or tetrahydric according to the number of OH groups present in the molecule.

The phenols can form:

Ethers—anisole— $C_6H_5.O.CH_3$

Esters—phenyl acetate— $C_6H_5.O.CO.CH_3$

Some of the basic groupings follow:

**Monohydric phenols**

- $C_6H_5.OH$  Phenol  
 $CH_3.C_6H_4.OH$  Cresols (ortho, meta and para)  
 $(CH_3)_2.C_6H_3.OH$  Xylenols

**Dihydric Phenols**

- $C_6H_4(OH)_2$  Catechol (ortho)  
 Resorcinol (meta)  
 Quinol (para)

**Trihydric Phenols**

$C_6H_3(OH)_3$  Pyrogallol

Just one more definition and we can turn to the actual chemistry of the various plastics. All chemical compounds are weighed out in mols or fractions or multiples of mols. This is an index figure arrived at by multiplying the molecular weight of each element by the number of its atoms present in the compound and adding the grand total to get the molecular weight of the combined substance. By using molecularly equivalent quantities, the nature of the product can be controlled and a large excess of any one reactant can be avoided.

We now have enough reference material to start following the reactions involved in the formation of the plastics common to today's market from the raw material through the creation of the molding compound, and less confidently, through the final molding itself.

### 1. Phenolics:

Although the general term phenol-formaldehyde is applied to this greatest (from the point of view of pound-age) group of plastics, such confining of terms is not too accurate; phenol-aldehyde type would be a better classification. The raw materials are usually formaldehyde  $CH_2O$ , and phenol  $C_6H_5OH$ , the (Continued on page 98)

# Vinylite resins

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Widely accepted for sound recordings, and available for countless other fabricated articles. Consider these properties—

The universal acceptance of "Vinylite" resins for electrical transcription records is

FOR SOUND  
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based upon their exceptional properties. Such records have a low initial noise level, good frequency response, are non-flammable and practically unbreakable. The unusual accuracy with which sound tracks are repeatedly molded results in remarkable fidelity of sound reproduction. "Vinylite" resins produce a thin record that does not warp or shrink, and high humidity does not affect its wearing qualities or distort the sound tracks.

The same properties which make "Vinylite" resins so highly satisfactory for

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records have created a wide demand for other fabricated articles. In addition to low moisture absorption, these resins are also non-toxic, tasteless, odorless and chemically inert

to the action of acids, alkalies, alcohols, oxidizing agents, oils, fats and greases.

"Vinylite" resins are excellent as liners for food, drug and cosmetic containers, bottle caps and a host of other commodities. Because of their dielectric properties, oil resistance and low moisture absorption these resins are used where electrical insulation is important.

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and pigments, in the form of sheets, rods and tubes. Such fabricated forms are non-flammable, non-warping, non-shrinking and can be stamped, formed or printed.

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PRODUCERS OF SYNTHETIC ORGANIC CHEMICALS

## A MOLDER'S ORGANIC CHEMISTRY

(Continued from page 96) latter coming from the benzene series above outlined. These are the most available ingredients in the market. Cresols can be substituted for phenols. Unfortunately the three cresols are mixed up in the commercial sources and ortho doesn't cooperate so well. Other compounds containing the phenolic groups are candidates, including the di-hydric phenols  $C_6H_4(OH)_2$ , catechol (ortho), resorcinol (meta) and quinol (para). Formaldehyde can be replaced by acetaldehyde, benzaldehyde or furfuraldehyde.

Phenol is a by-product of coal distillation or is prepared synthetically when the by-product price tends to get off line. Formaldehyde is made by the oxidation of methyl alcohol, which in turn comes in the course of the destructive distillation of wood, along with acetic acid, acetone and a group of other compounds. This price can also be held in line by synthetic production.

Phenol and formaldehyde are combined in the presence of a catalytic agent to produce phenolic resins. Rather peculiarly an acid catalyst will produce a resin permanently soluble and fusible, used in varnishes and lacquers, while in the presence of an alkaline catalyst the two principles react to form a resin which after the molding process becomes infusible and insoluble. Someone worked out a chemical name for the final molded phenolic, oxy-benzyl-methylene-glycol-anhydride.

### 2. Ureas, or amino-aldehydic resins.

Urea ( $NH_2.CO.NH_2$ ) can be used with the aldehydes just as phenol is used. Again formaldehyde gets the preference for commercial reasons. While the molding resin made with phenolics has a definite amber tint which prevents the development of pastel colors, the urea resin is water white which permits combination with brilliant and delicate dyes and pigments.

Thiourea, a compound very like urea except that a molecule of S stands in the place of the O, makes a very satisfactory molding resin for every one but the molder. The sulphur molecule loves to roam and the polished steel of the expensive die in which it finally comes to rest has an irresistible attraction, making chrome plating a necessity.

These two, the phenol and the urea-formaldehyde resins complete the commercial list of thermosetting compounds, that is, compounds that definitely alter their chemical construction in the course of molding under heat and pressure. When they emerge from the die in their final form they are entirely different from their state when they entered, in appearance, in chemical and physical characteristics. More compounds of this type may be coming along in the laboratories of the country, because the field is unlimited, but the obstacles in the way of price and control are pretty potent in themselves.

The second class which has risen rapidly in the last ten years, and to which there seems no end in sight is that of the thermoplastics, starting with cellulose nitrate and running through cellulose acetate, vinyl esters, styrol, methyl methacrylate and many more to come. If the phenolics and ureas can be likened to concrete wherein ingredients are blended and the hardened result

is fixed and to all practical purposes immutable, the second series can be likened to paraffin. Heat it and it melts, cool it and it hardens, a process that can be repeated again and again with no appreciable change in the material itself.

### 1. Cellulose Nitrate.

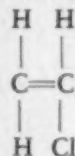
Purified cellulose, which has a nasty formula in which the unit  $C_6H_{10}O_5$  is repeated a great many times to the confusion of the onlooker, is treated with nitric acid and a dehydrating agent such as sulphuric acid to remove the water. All this must be done with great care because cellulose nitrate is highly inflammable. The resulting compound is mixed with solvents such as alcohol, or acetone and a plasticizer, for example, camphor. It then becomes a molding compound.

### 2. Cellulose Acetate.

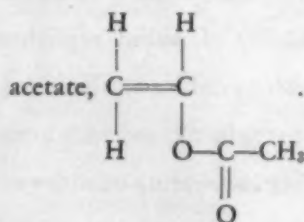
In this material the cellulose is treated with glacial acetic acid and acetic anhydride in a rather round about way to get a compound suitable for plastics. The great difference between the acetates and the nitrates lies in flammability and stability. Age and exposure to sunlight have little effect on the acetates.

### 3. Vinyl Resins.

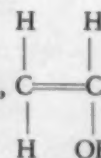
There is a comparatively simple radical  $CH_2=CH$ , called vinyl. Two useful vinyl compounds for the preparation of plastics are vinyl chloride,  $C_2H_3Cl$ , and vinyl



acetate,  $C_4H_7O_2$ . These compounds may be



considered as esters of vinyl alcohol,  $C_2H_3OH$ , although



this alcohol is such a bad actor chemically that it is of no use as a starting point in the preparation of these resins. By the co-polymerization of vinyl chloride and vinyl acetate, resins can be formed which are thermoplastic. They are odorless, tasteless, resistant to moisture, dilute acids and alkalies.

### 4. Styrol.

Styrene, alias phenylethylene,  $C_6H_5.CH=CH_2$ , has great possibility as a thermoplastic after enough molecules gather in a chain of somewhat dubious description through polymerization.

### 5. Methyl methacrylate.

The polymers of the esters of acrylic acid,  $CH_2=CH.CO.OH$  (alias ethylene carboxylic acid) and methacrylic acid,  $CH_2=C(CH_3).CO.OH$  (dropped an H and replaced by methyl radical) are available today as thermoplastic molding compounds.

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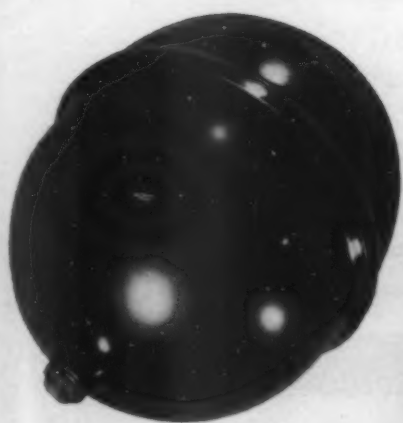
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| "             | " A.405—A pale quick drying enamel alkyd solution, 50% in Solv. #2                                |
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| "             | " A.409—A mill white low acid alkyd base.   |
| "             | " A.4090—This is A.409 solution 70% in Mineral Spirits.   |
| "             | " A.411—An extra long oil liquid paint alkyd (base).  |
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# MAKALOT

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*KADETTE Classic is so designed as to give practically same appearance front and back. This distinctive cabinet is molded of a beautiful non-streaking delicate shade of green MAKALOT trimmed with Plaskon and Tenite. The three different colored plastics molded with flowing cabinet lines produce a very effective color combination. Only the MAKALOT portion is shown above.*

**Molded by Chicago Molded Products Corporation.**

*Chicago Molded Products Corp. and Associated Attleboro Manufacturers, Inc., are two of the largest and most successful molders of Radio Cabinets in the country.*

The anniversary issue of our American Plastic Publication is highly significant, but of much greater significance is the fact that there is scarcely a day which is not the anniversary of a MAKALOT solution of some molding problem. The close knit and purposeful MAKALOT organization makes for speed and flexibility in both service and production.

In the molding of radio cabinets, a comparatively new and extensive use of phenolic plastics, appearance is perhaps the prime factor in the choosing of a raw material. Here again MAKALOT "shines."

Secondly, the size of the piece together with the cost of the die and the relatively few pieces per day, necessitates a molding material with which rejects are cut to a minimum or eliminated entirely.

Entering the field of radio cabinet materials and establishing its eminence by being the first compound of which the large Pilots could be successfully molded, all others having failed, MAKALOT has since been adapted to numerous cabinets, large and small. Shown are two of the most popular table radios, the success of one of which is due entirely to MAKALOT quality after competitive materials had proved unsatisfactory.

Experience, sad and otherwise, has taught these molders, and many others, that in the molding of radio cabinets as well as the majority of jobs, difficult or easy, MAKALOT IS THE SYMBOL OF GREATER PRODUCTION.

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Acid, alkali and water resistant specials, etc., etc.

Materials, formulae and experience to satisfy the variant needs of today's molders.

**P. S. To Foremen:**

**Mr. Foreman:**—When you are licked, discouraged and can't get out your orders, don't listen to the prattle or promises of the fellow who has not been able to solve your problem. TRY MAKALOT. In the Plastics anniversary edition last year, we cited seven concrete cases and reproduced photos of difficult jobs where competitive materials had failed. But Makalot licked every one in either a few hours or a few days. We can help you too.

## MAKALOT CORPORATION

262 Washington Street

**Boston**

**Mass.**

Factory, Waltham, Mass.

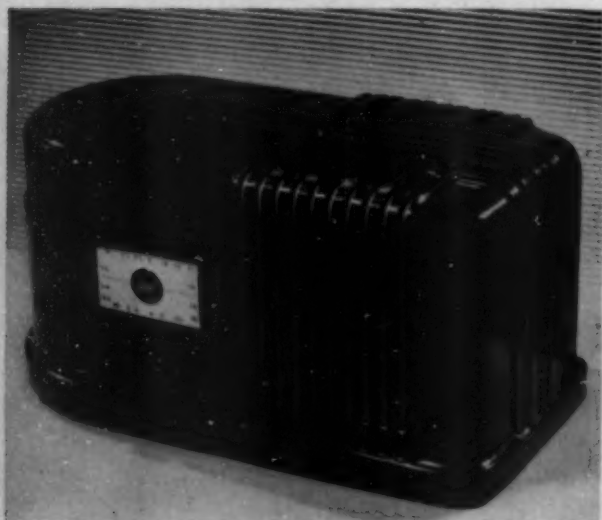
*Manufacturers of Molding and Paper Impregnating Resins, Lacquers, Varnishes and Alkyds.*

## PHENOLIC RESIN PROGRESS

(Continued from page 34) earlier applications of plastics in aircraft in that the earlier applications were carry-overs largely from automobile construction. In addition to radio communication on the airlines came the improvements in the lighting of the airways themselves. The Airways Equipment Corporation last June announced the new airport Boundary Light intended for use on the majority of the 10,000 new airports built by the P. W. A. at points not having electric current. The bulb is fed by a single dry cell. The conical shell of the marker is made of phenolic laminated so as to withstand perpetual exposure to the weather in all climates. The Kolster radio beacon uses a laminated tubing for the forms upon which the inductances are wound, and for panels for mounting the various units that require insulation of a dependable nature. The Boeing Aircraft Company concede that plastics have superior dielectric strength and are readily machinable. They do not absorb moisture and are desirable from the durability standpoint. Most of the material used by many of them is laminated phenolic composition. The Fairchild Aerial Camera uses phenolics on the two film guide rollers and in the metering rolls of each magazine. The Davidge Film Laboratory of Hollywood has created a new developing tank made of molded phenolics which enables the fliers to put their films in the process immediately after exposure, thus using to advantage the time of flight back to their base. Of course, an airplane manufacturer has really had no mass production, and this has retarded the use of plastics by these manufacturers, though many of the things they specify, utility, appearance, etc., can be supplied through the use of plastics.

Eastman Kodak Company, International Radio, and other camera manufacturers find phenolic plastics satisfactory for camera cases, when Eastman added the Bullet camera to its line, the job required exceptionally close tolerances—the multiple threaded lens tubes having

Sears Roebuck & Co.'s new Coronet radio in an all-molded cabinet features the use of curved surfaces to accent highlights. Molded by American Insulator Corp.



twenty threads 18 deg. apart on the circumference with .800 in. lead. The tube must have no taper whatever. Five or ten years ago such close specifications would have made the industry afraid to undertake such a job, and no one had ever attempted to mold a multiple threaded tube requiring such a high degree of accuracy in the threads.

Phenolic plastics, both laminated and molded, during the year have found interesting adaptations in display stands and small signs, one of which is Cory's display for face powder, another is that of Ingersoll-Waterbury for their time-pieces. Still another, the International Silverware stand. The permanency of the material and its coloring recommend it to such application, particularly where hard or long service is expected.

There has been an increasing acceptance by ship-builders of phenolic plastics in all their varied forms. The Richardson cruisers are now using door knobs, latches, drawer pulls and other parts of molded phenolic. Plastics have been used extensively as adhesives in plywood for partitions and decorative panels, and in laminated form for bars, table tops and similar applications. In varnish form they have been used for deck and floor coatings, as well as protective coatings in interiors, hull interiors and below water-line surfaces. They have reduced weight and contributed their bit toward protection from fire at sea.

Resins offer many advantages in the building field through laminated sheets of paper bonded together with resin, with colorful surface finishes or wood imitation, resin-bonded lumber and metal and wood panels. These new forms of construction material offer advantages to the architect and builder in design possibilities, are adapted to the unit type of construction and are easily and rapidly assembled. One resin-bonded plywood installation, caught in a flood, was under water two weeks, then frozen solid. When dried and cleaned, wall panels showed no evidence of deterioration whatsoever.

The H. H. Robertson Company in their "all-steel house" incorporated "bonded metal" wall panels comprising steel, asbestos and wood veneer, bonded with phenolic resin. These attractive walls are crack-proof, vermin-proof and shrink-proof, and are fire-resistant. This paneling offered expensive wood finishes to the householder at a comparatively low cost and in the model house built by this manufacturer, finishes of satin-wood, ebony and walnut veneers were used in the entrance hall. In the bathrooms were the same finishes in white and tan.

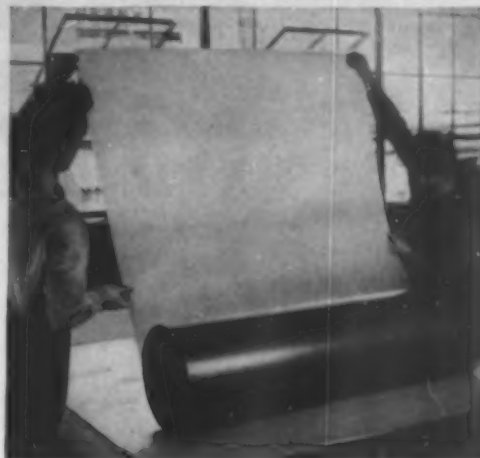
Manufacturers of laboratory equipment have recognized the superiority of phenolic plastics in their imperviousness to acids. An interesting example was their adoption for the Ohaus laboratory scale plates.

Larger moldings are constantly appearing such as the Pilot Radio cabinet, the Neosign Theater Box office sign, and the Barnham Tomato Juice dispenser. Plastics have also advanced in the telephone manufacturers' acceptance and have become standard material. Kellogg Switchboard & Supply Company's handset telephone and wall set have no exposed metal parts.

The Roll Case Mfg. Company with the cooperation of molding organizations adapted (Continued on page 104)

**An  
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BLACK  
BROWN  
and  
RED  
INORGANIC  
PIGMENTS  
for  
coloring or toning  
MOLDING POWDERS**

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EASTON • PENNSYLVANIA



**SYNTHETIC  
RESINS  
IN INDUSTRY**

*An Application to Plywood*

SOME of the important progress based on synthetic resins concerns not only the manufacture of entirely new products, but also the fundamental improvement of older ones.

**TEGO Resin Film** is a special phenolic resin in sheet form which, in curing under heat, displays exceptional adhesive properties. Interleaved in veneers of wood and subjected to hot pressing, it produces panels that are free from the usual weaknesses of plywood—especially their susceptibility to delamination. Millions of square feet of Tego-bonded plywood are now being produced monthly, and by virtue of a synthetic resin suited to its purpose the wood industry has found greatly expanded outlets.

Tego Resin Film, as well as a wide range of synthetic resins for special purposes, is made by *The Resinous Products and Chemical Company, Inc., Philadelphia, Pa.*

RESINOUS  PRODUCTS



5



6

5. Leich Electric Co. uses phenolic plastics throughout for the construction of their handset telephone. A special material is used which resists constant abrasion and perspiration. 6. Speakman Co. replaced the metal piston in the toilet flush valve with a unit molded of special moisture resistant Durez. Molded by American Insulator Corp.

(Continued from page 102) the idea of the old roll top desk and made tambours for cigarette cases, both pocket and table models, using parallel strips of phenolic plastic molded on to canvas backing.

Automotive brake linings have incorporated phenolic resins to the extent that today they are practically universal. These resins add, through impregnation of the various materials used, toughness, friction resistance, resistance to water and oil, and assure a lining that gives uniform friction coefficient without gumming even when extreme temperatures are reached. One large bus company reported that they secured 12,000 additional miles on phenolic resin-bonded lining. Of course, these same

bonding agents have proved successful in the manufacture of grinding wheels for years, and have recently taken an active place in the bonding of brush bristles.

While phenolic plastics have been used for housings on adding machines, calculators, electric meters, their adoption by the Hoover Company for the hood on their 150 Machine was definite evidence of the trend toward these materials for structural parts with strength and other qualifications distinctly their own. Molded plastics assure accurate assembly and alignment in close dimensional tolerances, reduce the weight of the piece and finishing costs, giving it a permanency that could not be secured in the metal formerly used.

The American Machine & Metal Company use plastics for their hair dryer helmet, one of several developed during the year. This large molding requires about four pounds of material and measures 18 in. by 19 in. by 11 1/2 in. by 10 inches.

Temperatures up to 450 deg. will not affect moldings made of heat-resistant material. While the material is only supplied in the darker shades, either black or brown, it is of course intended for such uses as electric iron handles, heater and appliance plugs, and other parts that must retain their dielectric strength without carbonization under relatively high heat.

Much activity has been experienced in the boxing and housing of razors, electric razors invariably having plastic housings, and except for those made in white, they have been phenolic moldings, the latest of which is that put out by Remington Rand Inc. The Packard with its all-phenolic housing is a leader among sales.

Observant of the versatility of these phenol-formaldehyde resins, one agricultural college and a state soil analysis group have used them in varied ways: one, as a container for filing soil specimens; another, for a bond to hold globules of earth together in some of their testing and analysis work.

While the use of phenolic plastics has grown tremendously during the past few years there are still virgin markets remaining, and manufacturers in many fields have not yet given them the consideration they should as a basic material of construction. Railroad men habitually think of metal. They have been brought up to metal, but they are streamlining their trains—to make them more attractive—and while they have accomplished much in the way of design they too will become acquainted with the practical applications of plastics. The lightness, cleanliness, durability of these materials, for doorknobs, window sills, arm rests, table tops, car trim, lighting fixtures, air conditioning parts and dining car accessories is bound to be recognized before long.

Plastics are inevitable in the adding machine, typewriter, dictating machine, check-writer and similar business machine fields. Though progress here has been relatively slow, the year has seen many new departures from tradition, and the business machine designer, manufacturer and engineer have definitely accepted phenolic plastics as a basic structural material.

**Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.**

**EXPERIENCE . . . . . over twenty years**  
**CAPACITY . . . . . for large production**  
**CONFIDENCE . . . . . of the industry**  
**KNOWLEDGE . . . . . of its requirements**  
**PREFERENCE . . . . . of our products**

These are a few of the reasons for our  
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**FOR THE PLASTIC INDUSTRY**

May we have your inquiry?

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(SOLVENT ALCOHOL)

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**CHEMICALS OF QUALITY**

## Monsanto

## VINYL RESINS (INCLUDING POLYSTYRENE)

(Continued from page 45) soluble in lower molecular weight alcohols, esters, ketones, aromatic hydrocarbons



Demonstration of laminated safety glass bending and rolling after it has been cracked by impact

and chlorinated hydrocarbons, and insoluble in petroleum solvents, oils, fats, water and glycols. Phthalates, glycolates and phosphates may be used as plasticizers. The resin is compatible to varying degrees with a number of natural and synthetic resins, such as ester gum, shellac and chlorinated rubber resins.

Various grades of the resin may be used in surface coatings, for injection or press molding, for extruding rods or tubes or for making sheets. The fabricated forms may be drilled, stamped or machined.

When formaldehyde is used to replace acetate groups of poly vinyl acetate, the resulting resin is odorless, tasteless, nearly colorless and has a higher softening point, higher impact and tensile strength, and lower degree of solubility than the acetaldehyde resin of the same percentage replacement.

Formaldehyde replacement resins are insoluble in alcohols, toluol, xy'ol, benzol, petroleum solvents, fats, waxes and glycols. They are soluble in chlorinated hydrocarbons, acetic acid, dioxan and furfural. This resin has excellent heat and light stability and is hard and tough. Certain grades made from low viscosity poly vinyl acetate are suitable for surface coatings. The grades made from medium or high viscosity poly vinyl acetate must be plasticized to make them suitable for molding, or extruding into rods or tubes.

The butyraldehyde replacement resins are characterized by exceptional clarity, toughness and heat and light stability. Like other aldehyde replacement resins, the properties can be made to vary rather widely by selection of poly vinyl acetate used, and the percentage replace-

ment. At the present time only one grade of this resin is being produced commercially.

Some physical properties of this particular grade are given in Table II.

TABLE II

|  |                 |
|--|-----------------|
| Specific Gravity   | 1.11            |
| Tensile Strength lbs./sq. in.                            | 8100-8500       |
| Notched Impact ft. lbs./specimen (.5 X .5 bar .1" notch) | .44-.60         |
| Modulus of Rupture—lbs./sq. in.                          | 11,400          |
| Heat Distortion Point (A.S.T.M.) °C.                     | 57-58           |
| Water Absorption—16 hrs. @ 60° C. (A.S.T.M.)             | 3-5%            |
| Resistance to alkalis                                    | Moderately good |
| Resistance to acids                                      | Poor            |

Solvents for the present commercial grade are methanol, ethanol, isopropanol, butanol, cellosolve, methyl and butyl cellosolve and dioxan. The resin is not dissolved, but is swelled by ketones, aromatic hydrocarbons, organic esters and chlorinated hydrocarbons. It is rather difficult to work on ordinary mechanical equipment unless plasticized. Plasticizers such as dibutoxyethyl phthalate and 3-GH are satisfactory.

Thus far the use of the one grade of this resin being manufactured has been confined largely to the safety glass field, where the extreme clarity, heat and light stability, adhesive properties and great strength of the resin, make it particularly desirable. This use is rapidly growing and, as production facilities are expanded to take care of increasing demand and costs are correspondingly reduced, this resin should fill many industrial needs in the fields of surface coatings, molded objects, sheets, rods, tubes and coated and impregnated fabrics.

### Vinyl acetate-vinyl chloride copolymers

Vinyl acetate-vinyl chloride copolymers are, as the term implies, resins resulting from the conjoint polymerization of vinyl acetate and vinyl chloride. Theoretically, the resin molecule consists of a linear chain in which monomeric vinyl chloride and vinyl acetate have reacted with themselves and with each other to form a conjoint polymer. The relative proportions of vinyl chloride and vinyl acetate in the chain depend upon the composition of the reaction mixture, and the length of the molecule is controlled by the reaction conditions at the instant of formation.

Although it is unlikely that production of vinyl acetate-vinyl chloride copolymer resin with polymers all of a single size will be achieved, it is possible and practical, by carefully controlled manufacturing conditions and use of the purest of raw materials to produce an average high, low or medium molecular weight resin. The properties of the resin are closely associated with the molecular weights and relative percentages of the polymer bands of which the resin is composed, as well as the vinyl acetate-vinyl chloride ratio. As the average molecular weight is increased, the effect of solvents on the resin is lessened, the plasticity decreases and modulus of elasticity and rupture increase, as does the tensile and impact strength. As the vinyl acetate per-

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**CHAS. TENNANT & CO. (CANADA) LTD.**  
372 Bay Street, Toronto 2, Canada

centage is increased, the water absorption increases, solvents have more effect on the resin, the softening point of the resin is lowered, and degree of compatibility with other resins is increased.

A vinyl acetate-vinyl chloride copolymer, to constitute a versatile material of maximum industrial utility, should combine as far as possible, the excellent clarity, heat and light stability of poly vinyl acetate with the high degree of chemical resistance of poly vinyl chloride, and should form a resin of the highest molecular weight that may be readily compounded, calendered or molded under average plant conditions, and which, for surface coating applications, is easily dissolved by commercially available organic solvents. Such a resin is being produced commercially with an 87-13 vinyl chloride-vinyl acetate ratio. Some physical properties of this resin are listed in the Plastics Properties Chart at the end of this section.

#### *Compounding of copolymer resin\**

Copolymer resin is produced commercially in the form of a fine powder, which may be easily compounded with fillers, pigments and plasticizers, by the use of heated internal mixers, and two roll differential mills, of the type ordinarily used for rubber compounding. Since the thermal life of the copolymer resin is somewhat affected by direct contact with iron or steel at elevated temperatures, best results are obtained if the parts of the compounding equipment with which the resin comes in contact, are chromium plated. In any case, small amounts of heat stabilizers, usually 1.5 percent, to 3 percent, such as lead stearate, lead oleate, or calcium stearate, should be added to the mix. It is also advisable to add a small amount, say 1 percent, of a lubricant such as carnauba wax, to prevent occasional sticking of the resin to the compounding equipment.

The usual compounding procedure is to dry blend the required amount of resin, stabilizer, filler, pigment, lubricant and plasticizer, and charge to heated mixer or roll mill. Equipment temperatures of 200 deg. F. to 275 deg. F. are used, depending on the amount of filler and plasticizer. Eight to ten minutes mixing ordinarily will be sufficient for thorough compounding. The resin,

\* Henceforth in this discussion of vinyl acetate-vinyl chloride copolymer resins, the term copolymer resin will refer to the 87% vinyl chloride-13% vinyl acetate variety unless otherwise stated.

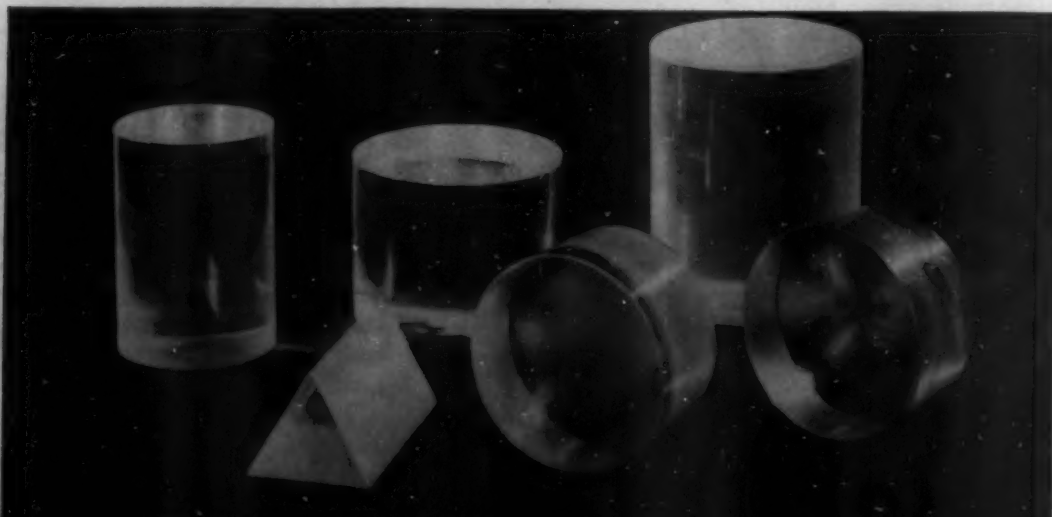
or resin-filler mix, may be taken from the hot rolls in sheet form and cut while warm into preforms, for direct use, as such, or for subsequent grinding to granular form.

Many relatively inexpensive fillers are suitable for use with copolymer resin, such as clay, talc, slate flour, mica, asbestine, whiting, carbon black, blanc fixe, alpha pulp, super floss, etc. Fillers and pigments containing iron or zinc should be avoided. Where an unusually flexible product is required, a number of plasticizers of the glycolate, phthalate and phosphate type are suitable for use. Examples are: dibutyl phthalate, kronisol, lindol, anticizers B-16 and M-17, plasticizer 3-GH.

*Copolymer resin molded.* Articles molded from copolymer resin exhibit exceptional and very desirable properties in that warpage, shrinkage, water absorption, breakage, effect of common corrosive agents, tendency to cold flow, are practically nil. The resin is quite clear as produced, so it is possible to compound the material to make very delicate pastel shades. The above facts, coupled with the non-flammability, complete lack of taste, odor or toxicity, combine to make this an ideal material for molded dentures, cosmetic and food containers, bottle caps, radio parts, automobile and refrigerator parts, steering wheels, fountain pens. Toothbrushes molded from this resin are very strong and tough and do not warp, crack or check. A large proportion of the electrical transcription records for broadcasts are molded of copolymer resin. Such records have a very low initial noise level, excellent frequency response, and long life, and sound tracks may be placed very close together to provide a complete program on a single disc. Since the molded record has no tendency to warp and thus distort sound tracks, it may be molded in very low thicknesses with a consequent saving of material. Because of the permanent thermoplasticity of copolymer resin, the material will continue to flow evenly as long as molding heat and pressure are applied, thus making it possible to mold large barrels and other sections for plating installations. The resin is well suited for this use since it is entirely unaffected by plating solutions.

For orthodox press molding, the resin may be used as a preform cut or stamped from milled sheets, extruded ribbons or rods, or preforms may be made from granular stock with the standard types of pilling machines, or resin may be charged to the mold in granular state. Molds should be of the semi-positive type, and about

Illustrating the clarity of polystyrene by machining a small piece from the cylindrical block. (Photo courtesy Carbide and Carbon Chemicals Corp.)



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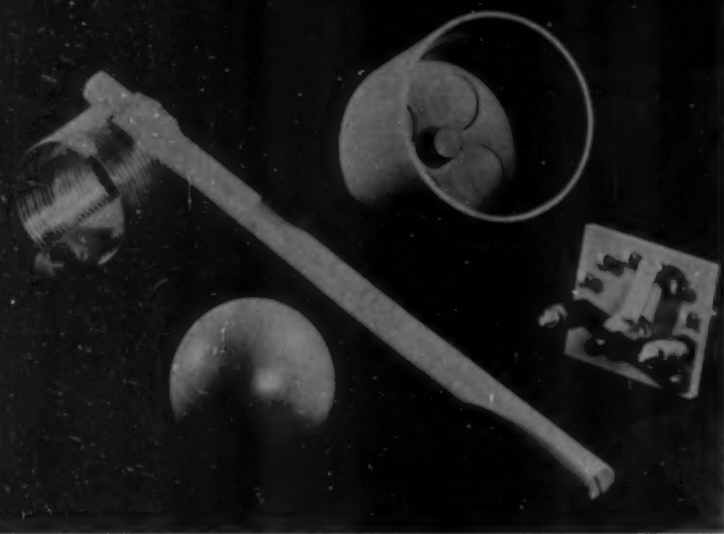
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.003 in. clearance should be allowed for escape of flash when using unfilled material, with slightly greater clearance for filled stock. To properly anneal castings the temperature of mold and casting should be 270 deg. F. to 290 deg. F. as mold closes. Pressure of 2000 lbs. per sq. in. of mold area is high enough for most any design of molded piece. Castings should be cooled to about 100 deg. F. before releasing pressure and opening mold.

Copolymer resin may be injection molded readily. However, since the resin does not have indefinite heat stability, certain precautions should be observed for best results. All parts of the equipment that come in contact with the hot resin, except the die itself, should be chromium plated and properly designed heating units must be used. A temperature of 290 deg. F. to 300 deg. F. is normally used for injection molding of this resin.

**Calendered stock.** Copolymer resin, filled or unfilled, may be calendered at reasonable speeds on calender equipment of the type ordinarily used in the rubber industry, at temperatures of 200 deg. F. to 275 deg. F. depending on amount of filler and plasticizer used. Continuous lengths of stock from about .002 in. to .250 in. in thickness may be produced.

Because of the extremely good moisture and grease resistance and lack of odor and taste, calendered film stock is exceptionally well suited for lining of food cartons, sausage casings and the like. Since copolymer resin is an excellent thermoplastic adhesive, calendered film stock is well suited for the laminating of wood, paper and fabrics of all kinds.

Clear film stock may also be transferred to decorated paper or fabric by heat and pressure in a continuous operation. This gives a transparent, non-flammable, highly resistant protective coating that brings out printed colors and gives them depth. Such a coating serves admirably for lamp shades, file folders, instruction cards, magazine covers, etc.

Because of its good electrical properties and high moisture resistance, copolymer film is well suited for insulating interlayers in small motor coils, slot insulation,

and as outside wrapping for electrical coils. Millions of square yards of paper that has been calender coated with a thin film of the resin have been supplied for bottle closure liners. Resistance of the film to corrosive agents, together with lack of toxicity, odor or taste, make it suitable for sealing almost any type of packaged product.

Colored film may be calendered on paper for table tops, shelf covers or for any similar use where a washable, resistant coating is required. Plasticized copolymer resin, filled or unfilled, when calendered on fabric backing, gives a product that far exceeds the standard test requirements for resin coated cloth on flexing, folding and exposure tests. Cloth coated with copolymer resin may be easily embossed in any design with standard equipment of either the roll or plate type. The material is well suited for upholstery, book covers, luggage covering and other similar applications.

**Sheets—rods—tubes.** Sheet stock may be secured in all plain colors in transparent, translucent or opaque, in either polished or matte finish, in almost any thickness required from about .010 in. to .500 in. Such sheets may be printed, stamped, engraved, blown, swaged, machined, sawed or molded. Because of no surface warpage to distort vision, copolymer sheets are well suited for use as automobile sun visors to eliminate road glare, reduce direct glare of sun or approaching headlights. For sun visors, dye combinations are used that absorb the light bands that contribute most to eye strain, while passing, but reducing in intensity the light bands that contribute most to vision.

Copolymer sheets are well suited for manufacture of articles where even slight warpage or shrinkage cannot be tolerated, such as triangles, T-squares, slide rules, looseleaf bindings and similar articles. Because of alcohol, water and perspiration resistance and non-flammability, sheets of the resin are well adapted for manufacture of long life playing cards, file tabs, card cases, magazine covers, ladies' hand bags and similar articles.

Rods and tubes of copolymer resin, in any solid color, may be extruded with standard equipment. Either filled or unfilled resin may be used, and such extruded shapes may be sawed, machined or threaded. Rods of irregular shapes are suitable as preforms for press molding, for picture frames, cove molding, etc. The complete resistance of the material to most inks, makes tubes of copolymer resin well suited for fountain pen manufacture, while moisture resistance and electrical properties suit tubes for use as shells for radio condensers. The resin may be easily extruded over wires at high speeds with standard equipment, to provide a moistureproof, corrosion resistant, low loss insulation.

**Surface coatings.** Surface coatings of copolymer resin are being widely used for industrial applications and have proved to be the solution to many problems that had not been solved by the use of any other material available. Because of the unusual properties of the resin, it may be used to advantage as the lining for metal containers for packaging of such products as beer, fountain syrups, shortening, fruit juices, soap solutions and bleaching solutions. As a coating on metal foil or paper

it is used for wrapping of food products. Due to extreme resistance to alkalis and acids, the resin is used to coat concrete, composition wallboard, hotel and hospital furniture and sheet metal for stamping into screw caps. Solutions of this resin are also used for coating or impregnating fabrics, to make shoe box toes, rain coats, shower curtains, "starchless" collars, and cuffs.

Copolymer resins are quite clear, so any desired color, including whites and delicate pastels, may be obtained. Coatings are tough, durable, extremely resistant at ordinary temperatures to such corrosive materials as sulphuric, hydrochloric, hydrofluoric and nitric acids, aqua regia, sodium and potassium hydroxide solutions, potassium permanganate and dichromate, silver nitrate, etc.

The resin is soluble in ketones, chlorinated hydrocarbons, esters and poly-ethers. The ketones and chlorinated hydrocarbon solvents permit the highest concentration of resin in mobile solution. Because of the toxicity of the chlorinated hydrocarbon solvents, the ketones, such as acetone, methyl ethyl ketone, methyl isobutyl ketone, etc., are preferable as the active solvent. Coal tar derivatives, such as toluol and xylol may be used as diluents. Alcohols and aliphatic hydrocarbons will tend to precipitate the resin if used in even small quantities, so their use should be avoided.

If highly flexible coatings are required, a number of plasticizers may be used, such as dibutyl phthalate, lindol, kronisol, some of the santicizers, 3-GH, and some of the aroclors. Copolymer finishes are of the baking type and usually are applied by spraying or roll coating. If held at the baking temperature for too long a period, the resin will undergo some color change, especially if the surface coated is a material, such as iron or zinc, which promotes resin decomposition. Practical methods have been worked out, and are in use, which effectively prevent discoloration during baking.

Pigmentation is best accomplished by making up color sheets or chips on a 2-roll differential mill and making a paste of such chips to be added to a clear base solution. Solution may be effected in cold solvents or solvent-diluent mixtures, with vigorous agitation of the mixture. Formulated copolymer surface coatings may be secured from lacquer companies in this country.

#### Conclusion

Vinyl resin plastics have proven highly satisfactory, and are being used in increasing volume for a great many diversified applications, and appear firmly entrenched in industry. When we consider the great versatility of this group of resins, their most desirable properties, the practically inexhaustible supply of domestic raw materials for their manufacture, the low cost volume production possibilities, it is apparent that the potential field of industrial uses for vinyl resin plastics has hardly been touched.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

## *Ameroid* CASEIN PLASTICS

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## ETHYLCELLULOSE—A NEW PLASTIC

(Continued from page 23) dium, underwent a tremendous change from the days of the ivory hair brush.

The use of plastics during the last few years has progressed with ever-increasing rapidity, and with this growth there has come a demand for new and newer materials to suit new and wider uses. Hence, today the introduction of a new plastic in all probability heralds, not necessarily increased competition in the existing field, but more probably an enlargement and extension of it.

The introduction of ethylcellulose into the plastics and allied fields comes in answer to a demand for a material having new and different characteristics which will permit the enlargement of the industry into virgin fields, and will facilitate the manufacture of articles having novel properties and uses. This cellulose derivative is not new, but its development has awaited a demand for the characteristics which its properties provide.

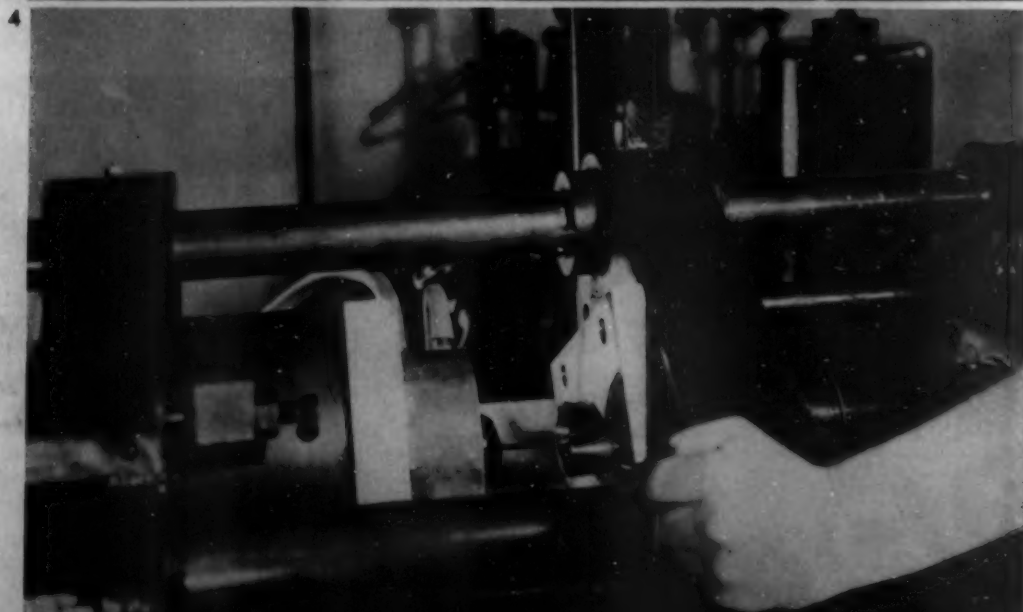
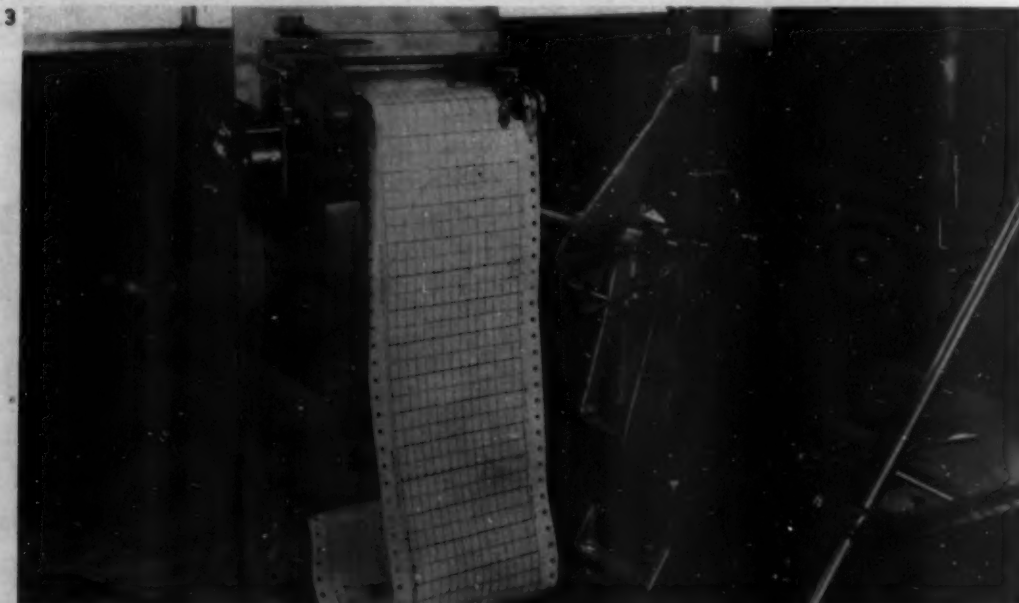
Chemically speaking this compound is an ether.

The ethyl group is joined to the cellulose through oxygen, and this structure has a wide and well founded reputation for stability to chemical action, and to the action of heat and light. Ethylcellulose exhibits the characteristics mentioned to a very marked degree, and these properties become even more outstanding as improvements in its manufacture continue.

Because of its ability to withstand considerable heat without degradation this derivative should, and does, fit well into the plastic field. Compression molding does not require a great degree of heat stability but injection molding provides a severe test for any molding material, since in being softened it is often subjected to high temperatures for rather lengthy periods. Ethylcellulose meets this challenge in two ways: First, it is inherently stable to relatively high temperatures, and, second, its softening point is low, and therefore it does not require a very high molding temperature.

The behavior of a plastic material when combined with modifying agents is of particular interest. The type and kind of plasticizer may vary with the purpose

3. The Olsen Flow Tester, although primarily designed for use with thermosetting materials, is a useful tool for studying softening and flow characteristics of thermoplastic materials. The curve here shown is for ethylcellulose plastic. 4. Ethylcellulose plastic injection molded knob about to be discharged from the mold



for which the molding material is intended, and very appreciable changes in physical or electrical properties may be effected by the proper selection of modifying agents. In this field ethylcellulose has no peer. It is a good mixer, being compatible with a wide range of plasticizers, resins and lubricants. Thus, in spite of the low softening point of the basic material, an ethyl plastic can be made which is both tough and hard at the use temperatures of the molded piece, and which still flows easily at molding temperatures, and thereby permits high production from low power presses.

Peculiar to ethylcellulose is its ability to combine with plasticizers by the aid of heat and mechanical working alone, thereby avoiding the customary solvent colloiding step with its subsequent slow solvent removal. The amount of plasticizer required is also much lower than for the older cellulose derivatives. This permits manufacture of a plastic in which the excellent properties of the basic material are subject to a minimum of change to achieve a given plasticity and at the same time, due to the low initial plasticizer content, the retention of this modifier is about 100 percent.

The electrical properties of ethylcellulose are very good, and its low moisture absorption favors the retention of superior performance characteristics under adverse conditions.

While high tensile strength of a molded piece is often claimed as a good criterion for evaluating a molding material, any molder or user of plastics very quickly comes to the realization that molded parts usually fail from shock rather than from tensile stresses. The cellulose derivatives have always been favorably known for their shock resistance, nor does ethyl fail to uphold the family reputation in this respect. In fact, an important property of this material as compared with other cellulose derivatives is its greater retention of toughness and flexibility at lowered temperatures.

With a material like ethylcellulose which is compatible with such a host of modifying agents, each of which influence one or more properties, it is difficult to set down even an average set of properties. This is particularly true of a plastic just emerging from the development stage. However, it is hoped that the data given in the Plastics Properties Chart at the end of this section may serve as a basis for preliminary comparison with other materials.

There is no worker in plastics who views the future of this industry with anything but optimism. The uses of plastics are increasing daily, and the time is not far distant when these products will be used as widely and generously as the now common construction materials. Each application will have its own requirements, and each plastic will share in this development as its characteristics dictate. The extensive use of ethylcellulose plastics in this field is to be predicted on the basis of its stability to light, its low water absorption and its retention of toughness at low temperatures.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

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## COUMARONE-INDENE

(Continued from page 22) dependable chemical inertness.

One type of cold molded plastic includes a blend of coumarone-indene resin with crude or reclaimed rubber to impart resilience. A grade of resin melting above 115 deg. C. is employed. The compound contains from 11 to 16 percent coumarone-indene resin with 6-8 percent crepe or reclaim rubber compounded with fillers and pigments on a rubber roll or internal mixer so that the pigment particles are thoroughly coated with binder. The mixture is sheeted and then ground cold ready for molding under pressure. An alternative method involves powdering fillers and binder separately and mixing thoroughly before molding. Baking at 100 deg. C. for 12-15 hours is claimed to improve the hardness and set of the articles made from this product.<sup>5</sup> Special coal tar pitches have been used as modifying agents for coumarone-indene resin in similar compounds.<sup>6</sup>

Sulphur has been used as a modifying agent for coumarone-indene resin in cold molded plastics. A mixture of approximately 69 percent of sulphur and 31 percent coumarone-indene resin is blended with inorganic fillers and cold molded into any prescribed shape.<sup>7</sup> Heat treating at 480 to 500 deg. F. for 16 hours is said to "vulcanize" the resin while some hydrogen sulphide is eliminated. A proportion of sulphur up to 40 percent remains combined with the resin, it is claimed, so that an article of pleasing black appearance and good electrical and mechanical qualities results.<sup>7</sup> Sulphur-coumarone-indene resin mixtures when used with fillers such as clay, sand, glass or brick dust have been used as a molten waterproof dielectric sealing compound for electrical blasting caps.<sup>8</sup>

Another type of molten sealing compound for insulating electrical coils has been developed by heating 85 percent coumarone-indene resin (M. P. 80-100 deg. C.) with 15 percent china wood oil until a clear liquid results. The resulting product, melting at approximately 60 deg. C., is claimed to serve as a permanent insulation.<sup>9</sup>

Possibilities for a thermoplastic resinous molding base are indicated in the blends of coumarone-indene resin with shellac which has been treated with zinc oxide and rendered permanently thermoplastic. A typical blend contains 50 parts shellac, 15 parts zinc oxide and 50 parts coumarone indene resin intimately mixed and heated between 200 and 280 deg. C. It is claimed that the resulting resinous blend may be melted to a moderate or low viscosity liquid.<sup>10</sup>

Waterproofing of articles made from Portland cement, such as insulators, etc., has been carried out by grinding the cement with coumarone-indene resin and fillers such as asbestos. After hydrating, molding and allowing the article to set, gradual heating causes the thermoplastic resin to flow and seal the pores.<sup>11</sup> When melted, this resin is comparatively low in viscosity so that it can be employed successfully as a treating agent for sealing insulators and other articles made from Portland cement.<sup>12</sup>

A combination of coumarone-indene resin and polyvinyl-acetal is used in the manufacture of transcription

records, and the resulting record is said to give fine reproduction with freedom from surface noise. The combination can be handled in regular record manufacturing processes. This type record is light in weight and preserves good strength, which reduces breakage in transit.

Some very interesting leather-like sheets have been produced by cold-milling (on rubber rolls) coumarone-indene resin with high isobutylene polymers of the vistanex type. A typical compound containing 75 parts hard type resin with 25 parts vistanex has good flexibility and chemical resistance. A sheet of this when moistened on one side with toluol shows satisfactory adhesion for metal surfaces and hence has been considered suitable as an acid and alkali resistant tank lining.

An interesting use for a thermoplastic composition containing coumarone-indene resin is in the production of transfer inks. Coumarone-indene resin is combined with bodied oils to which pigments are added to make a transfer ink compound. This is melted and applied by means of a deeply engraved roll to give designs on paper.<sup>13</sup> Combinations of coumarone-indene resin with oils and cellulose ethers have been used as fusible transfer ink compounds.<sup>14</sup>

Many possibilities exist for the use of coumarone-indene resin in stiffening, waterproofing and laminating paper. The simplest method involves introduction of the hard grades of resin in finely ground state into a paper beater where it becomes intimately mixed with the fiber prior to formation of the sheet. The resin is enmeshed in the sheet during formation and, by application of heat on the driers or by pressing and heating the sheet after it has been made, is more thoroughly distributed through the fibers, imparting water resistance and strength to the stock.<sup>15</sup>

The use of such sheets in laminating operations is indicated. In preparing resin suspensions for addition to the paper beater 50 parts or more of the resin may be ground to 200 mesh and stirred thoroughly into a solution of 5 parts of silicate of soda with 4 parts of resin oil in 100 parts of water. Grinding of the resin and solution together in a pebble mill is optional to adding powdered resin to the solution as described above.

Coumarone-indene resin may be employed in combination with oil-soluble phenolic resins in the saturation of paper or other fibrous sheets in the preparation of laminated fibrous materials.<sup>16</sup> This operation involves the saturation of paper such as Kraft with coumarone-indene resin in solution together with oil-soluble phenolic resin, or treating a fibrous sheet previously saturated with coumarone-indene resin with a solution of oil-soluble phenolic resin, and subjecting two or more sheets to heat and pressure to effect lamination. As early as 1912 the use of coumarone-indene resin with phenolic resins was mentioned by Baekeland.<sup>17</sup> The compatibility with quick curing type phenolic resins is limited, but the oil-soluble type of phenolic resins blends readily with coumarone-indene polymers.

Sheeted plastics have been made from molding powders prepared from powdered blends of cellulose ethers with pigments and fillers. When benzylcellulose is used it is

often associated with resins of the coumarone-indene type.<sup>18</sup> It is claimed that mixtures of coumarone-indene resin and benzylcellulose with chalk give a sealing wax which is equal to any on a shellac base.<sup>19</sup> In its variety of functions coumarone-indene resin stands unique as an agent in rubber compounding. Functioning as a softener it mills readily into the rubber, producing a smooth flowing stock with good tubing and calendering properties. It imparts a high gloss to molded rubber articles and, because of its low tinctorial power, will not materially change the shade of sensitive pigments. It appreciably retards bleeding of organic colors. Its excellent insulation properties make it a very desirable compounding agent in electrical cable insulation. In addition, it is useful in many other rubber compounds including hard rubber, sponge rubber, extruded compounds and tubing, heels, soles and many other products.

Many possibilities exist in utilization of this interesting resin in the vast field covered by industries employing rubber latex. One of the simplest methods<sup>20</sup> involves the emulsification of a plastic type of coumarone-indene resin or of a hard type to which a softener has been added. The emulsion is added to the latex in proportions indicated by the use intended. Such combinations may be used in different types of adhesives to which the resin imparts added tack and smoothness. Innumerable other uses for such blends are being suggested daily.

This brief discussion has illustrated, by various examples, the scope of usefulness of coumarone-indene resin in modern industry. The examples—based upon its many attractive properties as well as the wide range of other substances with which it is compatible—do not encompass all possible applications of coumarone-indene resins. The above description will indicate the potentialities of one of the most interesting thermoplastic materials yet discovered.

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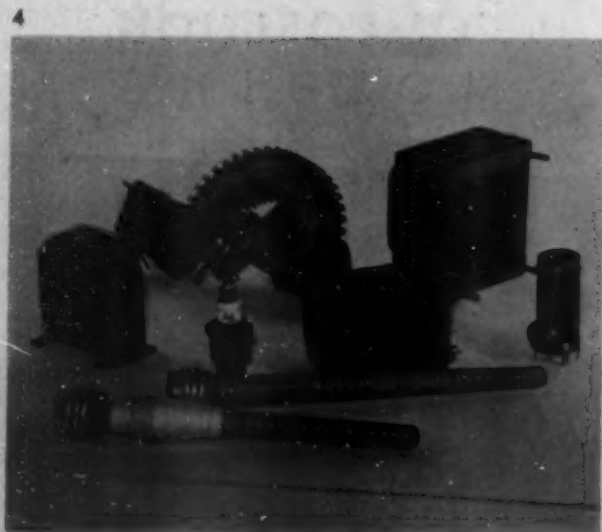
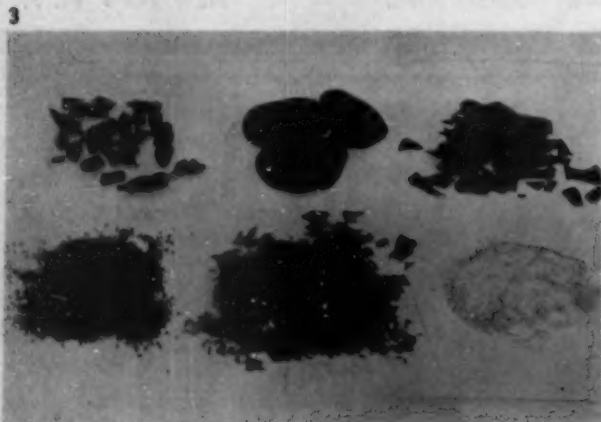
## SHELLAC: A GROWING FACTOR IN INDUSTRY

(Continued from page 37) a varnish and as a molten resin in preparing these compositions. The largest quantities of the laminated paper products are probably used for insulating tubes such as for the condenser type of terminals for transformers and oil circuit breakers, while the mica products are used for commutator segments and mica tape.

There has also been a large increase in demand for molded shellac insulators for transmission lines. Marked improvements have been made in the manufacture of these insulators during the last few years along lines which have been suggested by the author.<sup>2</sup> These improvements are manifested in better mechanical and electrical properties which are obtained by increasing the degree of polymerization of the shellac during the mixing of the composition on the plastic rolls or by heat treatment of the composition prior to molding.<sup>3</sup> In this field, asbestos is widely used as a filler. It varies in amounts from 50 to 75 percent of the composition.

The advantage of employing shellac as the plastic bonding agent in electrical insulation is due to its tendency to resist carbonization during arcing which may take place as a flash-over in high voltage transmission,

3. Different types of lac. 4. Mechanical objects where shellac is employed as a varnish



and to the fact the decomposition products which may result are poor conductors of electricity. Shellac insulators are not as fragile as porcelain, are not shattered when struck by a sharp object and are being specified by engineers both in this country and abroad for power lines which pass through inaccessible regions.

The revival of the automotive industries has also increased the consumption of shellac in the manufacture of grinding wheels. In these industries, grinding has passed from a fine art to that of a science where grinding machinery is controlled with the highest degree of precision instruments.

Considerable progress has also been made during the past year in developing shellac dental compositions and suitable plastics for making impressions.

The colors which can be obtained with shellac compositions are generally classified as limited. This impression has been gained largely from the fact that shellac moldings are now made usually in two colors, natural and black, which serve their useful purpose for the types of articles manufactured. It was not true for the past when shellac was more widely used in custom molding. The facts of the case are that shellac moldings can be made of almost any color in shades approaching the pastels from orange shellac if a sufficient amount of white pigment of high refractive index is employed.<sup>4</sup> Beautiful pastel shades and light creams can be obtained with bleached shellac of special plastic properties which is manufactured to a limited extent for these purposes. The preparation of molding powders from shellac compositions offers several possibilities.<sup>4</sup>

Any number of fillers are used with shellac to form various types of plastic compositions and the selection of this important ingredient depends on the use to which the material will be put. Asbestos, clay, filter-cel, silica, cotton flock, woodflour, mica and laminated paper are common fillers in the larger industries. These fillers are incorporated by both the wet or varnish process in mixers, and by the dry process on heated rolls. A large number of other materials which cannot be strictly classified as fillers are also combined with shellac. These include such substances as asphalt and wood tars, casein and glues, rubber and gutta-percha, various waxes, and synthetic resins such as the alkyds, phenolics and urea-formaldehydes. Patents have even been issued for plastic compositions containing shellac and such materials as sulphur, rice flour, dry yeast and creosote, Portland cement, Plaster of Paris, and oil and alum.<sup>5</sup>

### Other uses of shellac

The wide number of other than plastic uses of shellac forms an interesting chapter in itself. Mention of some of these as a means for possibly judging its future may not be entirely out of place in this paper. It is very likely to be found as a varnish around almost any factory or shop for use as a sealing material for innumerable purposes. Workmen have long used it for sealing the joints of pipes especially those carrying high pressure steam such as found in the press room in a molding plant. It has also been widely used as a cement for wood.

It has been used as a lining for tanks of various types, especially in fermentation processes, and as an ingredient in compositions for coating hoods and other equipment for carrying off corrosive fumes. Oil lines have been protected with its coatings.

Compositions containing shellac have been suggested for ore flotation and aeration. It has been employed as a backing in electrical etching processes; in graphite compositions for plating copper on wood, and as an ingredient in electro-plating rubber on aluminum.

It is used in the manufacture of explosives for lining shells, and in coating of time fuses. It is also used in making certain printing inks, adhesives, and for coating food products such as candy, for coating soap, and for coating pills so they will not dissolve in the stomach but will be soluble in the digestive fluids in the upper intestine. It has also been employed in the leather industry both as an ingredient of artificial leather and in the hardening of animal skins, in the stiffening of shoes and as coatings for fancy goods in this field. Felt and straw hats are also stiffened with shellac. In addition, it has been suggested as an ingredient in the manufacture of artificial rubber, and earthenware substitutes.

It is an ingredient in lacquers, water paints, ship bottom paints, automobile polishes, solid fuels for stoves, and waterproof compositions and as an ingredient of cork and of fireproof boards. Cloth fabrics have been impregnated with it. It is also extensively used in photo-engraving in the form of a light sensitized film. Fine briar smoking pipes are finished with it in order to fill the pores in the hard wood.

The mechanical arts have used it in compositions for rubber belting, friction composition, moisture-proof preparations for rope, for brake and clutch linings, in graphite compositions, and as a coating for floats for carburetors. It has been used in luminous paints for pointers of ammeters and voltmeters. It has also been used in the manufacture of metal yarns, backing for silvered mirrors and in case hardening where it is desired that only a portion of the piece coated with shellac be case-hardened. Tool handles have also been molded from shellac compositions.

This ever broadening distribution of the use of shellac has been a stabilizing factor on the market fluctuations which have sometimes resulted from shifting prices. The importations in general have shown a steady increase for many decades except during the past major business depression. If all the factors influencing the consumption of shellac could be obtained, they would make a very interesting and instructive technical and business study.

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## PHENOLIC-ASBESTOS FOR INDUSTRIAL EQUIPMENT

(Continued from page 35) possible to vary any one, or all of the rectangular tank dimensions at the same time by this unit amount. With this procedure, it became possible to manufacture tanks, up to the maximum sizes, within 3 in. of any dimension called for by the customer. Very material reductions in the price of rectangular tanks resulted, especially in small quantities.

At the present time, by no means all of the articles which can be made from this material, have been standardized; but the results of the previous experiences have been so satisfactory that further standardization can hardly help but follow.

A second problem, which presented itself quite soon after the American development was underway, was that of economically handling liquids and gases in pipe lines. It early became evident that a wide demand existed for pipe lines to handle corrosive liquids and gases to supplement previously existing materials. The chemical and physical properties of Haveg were such as to make a development in this line promising; but the processes previously used, involving as they did a large amount of hand labor, made such piping inherently expensive.

After several months of study, a much simpler process was devised, which permitted substantial reductions in cost. At the same time, a complete redesign of existing pipe standards was made, to bring them into line with American standards and with American needs.

The result of these two improvements was striking. Not long after the introduction of the new standards and the greatly lowered prices, which took place about two years ago, pipe applications began to increase rapidly and have been increasing ever since until now they represent a major outlet for this unique compound.

Recently still further design modifications have been introduced, intended for lighter service in the handling of fumes and gases, with a thinner construction and a still further reduced price.

Another interesting development has been in the production of various types of scrubbing towers and absorption towers. Three general types of these towers are required by the chemical industry. The first and simplest is the so-called "packed" tower, which consists essentially of a cylindrical tank filled with rings over which the liquid and gas flow. Such towers were among the earliest applications of this material in this country and have steadily advanced in popularity for uses where the simpler types of towers are satisfactory. For some applications, however, more complicated towers are required, as in the so-called plate columns. Such columns consist essentially of a series of plates, either provided with many small holes, or containing bubble caps which break up the flow of gas. Each plate usually retains a small quantity of liquid above it and for certain applications, much greater efficiency is possible.

Within recent months it has become possible, through improved designs, to adapt this material also to the more complicated type of tower thus described. The basic design feature which permitted this was the use of small trays or tanks in which the bottom is used as the plate. These trays or tanks were then superimposed one upon the other to form the height desired.

Certain definite requirements of the chemical industry have resulted of necessity in the production of various odd shaped and special tanks. Among them may be listed cone bottom tanks, which permit complete drainage of the liquid; round bottom tanks, which are used for the same reason; suction filters; condensers, and similar items. By a modifica- (Continued on page 120)

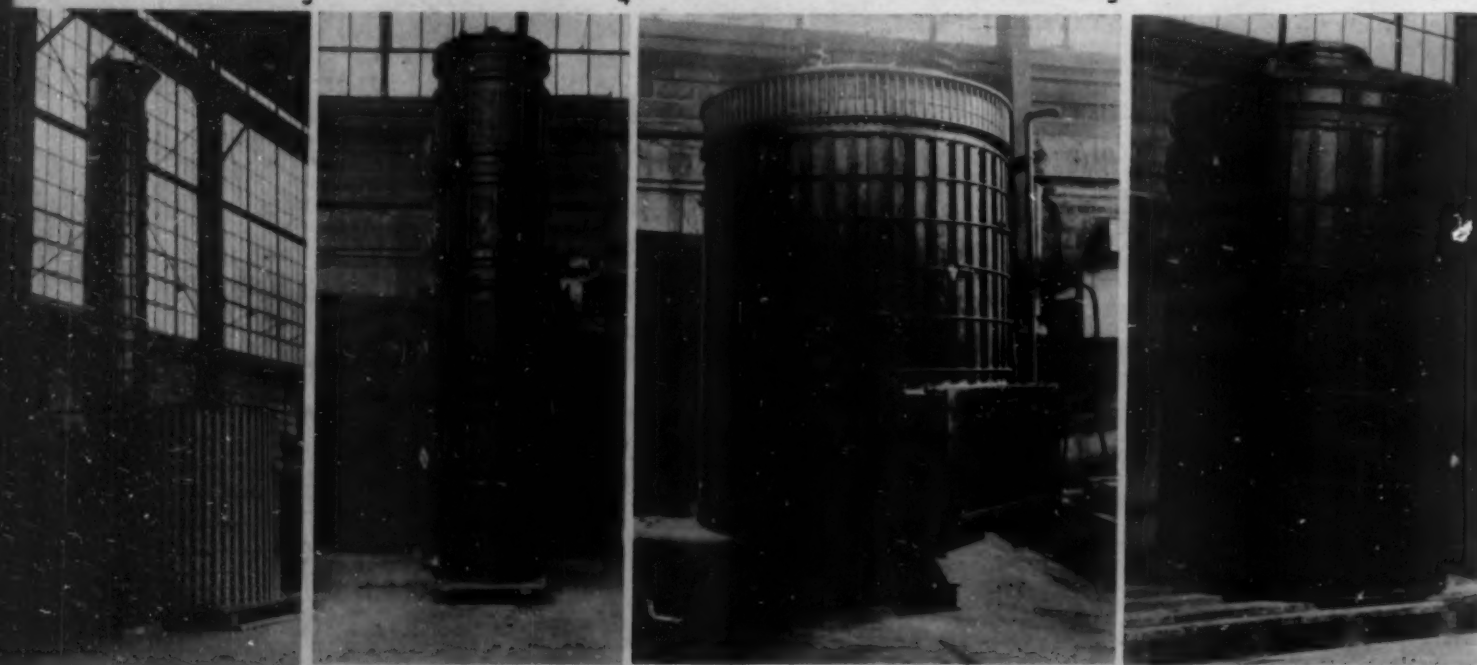
3. Packed type phenolic tower 30 in. diameter by 30 ft. tall. 4. Plate type column, built in form of trays. 5. 7 ft. diameter cone bottom tank with tube sheets and disked cover. 6. Standard cylindrical tank with disked cover. (All photos courtesy Haveg Corp.)

3

4

5

6



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## PHENOLIC-ASBESTOS FOR INDUSTRIAL EQUIPMENT

(Continued from page 118) tion of the molding process, it has now become possible to produce tanks completely hollow. Previously, tanks were molded with the walls and bottom integral, but with a removable cover. It has now become possible to mold the cover also integrally—the only requirement being that a man-hole be provided in the design. Closed tanks of this nature have decided advantages for many applications, particularly for horizontal tanks, and a number have been sold within the last year.

Still another field, in which applications of the material have become increasingly important, is that of the pickling and plating of metals. Haveg tanks have been used in this service for several years in this country, and for many years before that in Germany. They are, however, usually rectangular tanks, and as a result of the standardization described above, there has been a very greatly increased application in these fields, which has become a very important outlet.

The developments of this unusual phenolic material which have been discussed above, have been based primarily on chemical applications, and it is in this field that it has had its major application to date.

There are, however, other fields in which it is beginning to find decided use and where corrosion as such is no problem at all. Included in this category may be considered electrical applications.

While the normal grade of the material has relatively poor insulating value, it can be produced in special grades which give very satisfactory results. This property makes possible the production of larger size molded electrical equipment. In this connection it should be made clear that Haveg has certain limitations. It is, for instance, not a material which is susceptible of close molding tolerances. Where exact dimensions are required, machining is usually resorted to on the finished molded part. It cannot be used at temperatures in excess of 265 deg. Fahrenheit.

It should be stressed that Haveg is not a molding compound, but a molded material, and can be produced, at present, only at the factory. It is not, therefore, adaptable for use by the ordinary custom molding technique. It can, in other words, be used mainly for those applications which would require a large or a medium sized molded object, required in quantities too small to justify a conventional mold.

The applications of the material in fields other than chemical, textile and metallurgical, are as yet small; but are steadily growing, and seem to indicate the possibility of further developments in such fields.

Killefer, D. H., *Ind. Eng. Chem.*, vol. 25, no. 11, page 1217 (1933).  
Adams & Bell, *Amer. Dyestuffs Reporter*, page 342, June 18, (1934).  
Adams, W. H., Jr., *Trans. Am. Inst. Chem. Eng.*, vol. 30, page 317 (1934).  
Torr, L. W., *Ind. Eng. Chem.*, vol. 27, page 1284 (1935).  
Adams, W. H., Jr., *Chem. & Met.*, vol. 41, no. 7, page 349 (1934).  
Adams, W. H., Jr., *Modern Plastics*, March, 1936.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

## NITROCELLULOSE

(Continued from page 31) this principle and the courts held that they were entitled to patent protection on it.<sup>4</sup> The same company has been an important factor in the utilization of low viscosity regenerated cellulose waste as a raw material for nitrocellulose.<sup>5</sup>

### Current trends

A major tendency at the present time is the replacement of cotton cellulose as a raw material by the more inexpensive wood pulp. This has been a laborious process because of the necessity of removing the lignin from the wood pulp, the difficulty of getting the fibers into the properly absorptive shape which would give good nitration but at the same time permit low loss of fines and subsequent purification and the difficulty of adjusting the acid concentrations to give the desired product. This work was given an impetus, however, by the German necessity for dependence on home-grown cellulose, and American firms are now making substantial amounts of wood pulp nitrocellulose. The use of low viscosity regenerated cellulose waste has already been mentioned and note should perhaps be entered of the use of considerable amounts of 12 percent photo film scrap in artificial leather.

In the protective coat field, the alkyd resins have made tremendous progress on account of their hardness and durability, as well as high solids content of solutions; but are limited by the necessity of baking. There appears to be a strong tendency at present to add low viscosity nitrocellulose (18-23 centipoises) to a wide range of protective coating in order to utilize the quick drying and the water resistant film formed by this material. The low viscosity sacrifices slightly in toughness but permits inclusion of much larger solids per gallon of lacquer.

While the lacquering of paper has shown some growth, a most fruitful field of expansion for nitrocellulose appears to be in their application as water emulsions.<sup>6</sup> These are safer as a fire hazard and also permit the deposition in one coat of almost any weight film on absorptive surfaces such as wood, paper and leather.

Present indications are, therefore, that new materials will continue to make inroads into some of the established uses of nitrocellulose; but that new uses, and the advantageous properties above enumerated, will keep this cellulose derivative a major factor in the plastics and protective coat industry for some time to come.

<sup>1</sup> Private communication, Mr. J. B. Wiesel.

<sup>2</sup> Meyer & Mark, *Ber.*, 61B, 593-614 (1928); *Chem. Abstracts*, 1929, page 1263.

<sup>3</sup> A. Parkes, *English* 2359 of 1855, and others.

<sup>4</sup> E. M. Flaherty, U. S. 1,629,999, Re. 16,803, held valid by the United States Circuit Court of Appeals for the Second Circuit, with respect to Claims 2, 3, 6, 8, 9, 12 and 17. July 10, 1933 and November 13, 1933.

<sup>5</sup> P. B. Cochran, M. V. Hitt and L. Van Taylor, U. S. 1,997,766, April 16, 1935.

<sup>6</sup> U. S. 1,589,328, 1,793,983, 2,044,571 and 2,044,572.

<sup>7</sup> MODERN PLASTICS, Oct. 1936.

Manufacturers of these materials, with addresses and trade names, will be found in the Directory Section.

The values for the properties in the accompanying chart are based upon maximum some cases if direct comparisons are attempted. Special grades of communication with the producers of these mater

| PROPERTIES  | PHENOL-FORMALDEHYDE COMPOUNDS                                       |                    |                    |   |                       |                     |                                | PHB                   |
|---|---|--------------------|--------------------|---|-----------------------|---------------------|--------------------------------|-----------------------|
|   | Molding   |                    |                    | Laminated                                     |                       |                     | Cast                           |                       |
|   | Woodflour Filler  | Mineral Filler     | Fabric Filler      | Paper Base                                    | Fabric Base           | Asbestos Cloth Base | No Filler                      |                       |
| Molding Qualities   | Excellent   | Excellent to fair  | Good to fair       | —   | —                     | —                   | —                              | Excellent             |
| Compression Molding Temp., ° F.   | 280-360   | 270-350            | 270-330            | 250-365                                       | 250-365               | 250-325             | —                              | 330-400               |
| Compression Molding Pressure, lbs. per sq. inch   | 1600-4500   | 1600-6000          | 3000-8000          | 1000-3000                                     | 1000-3000             | 1000-3000           | —                              | 1000-3000             |
| Injection Molding Temp., ° F.   | 275-375   | 275-350            | —                  | —   | —                     | —                   | —                              | 250-290               |
| Injection Molding Pressure, lbs. per sq. inch   | 2000-10000  | 2000-15000         | —                  | —   | —                     | —                   | —                              | 300-5000              |
| Compression Ratio   | 2.5-3.0   | 2.2-7.1            | 2.5-11.0           | 1.5-3.0                                       | 1.5-3.0               | —                   | —                              | 2.5-3.0               |
| Mold Shrinkage, inches per inch   | 0.006-0.010   | 0.002-0.006        | 0.003-0.007        | —   | —                     | —                   | —                              | 0.005-0.006           |
| Specific Gravity  | 1.34-1.52   | 1.70-2.09          | 1.37-1.40          | 1.34-1.55                                     | 1.34-1.55             | 1.6-1.65            | 1.27-1.32                      | 1.3-1.4               |
| Specific Volume, cubic inch per lb.   | 20.7-18.2   | 16.4-13.3          | 20.2-19.8          | 20.7-17.8                                     | 20.7-17.8             | 17.3-16.8           | 21.8-20.0                      | 21.3-19.3             |
| Refractive Index, $n_D$   | —   | —                  | —                  | —   | —                     | —                   | 1.5-1.7                        | —                     |
| Tensile Strength, lbs. per sq. inch   | 6000-11000  | 5000-10000         | 6500-8500          | 6000-13000                                    | 8000-12000            | 9000                | 5000-12000                     | 5000-12000            |
| Elongation, %   | —   | —                  | —                  | —   | —                     | —                   | —                              | —                     |
| Modulus of Elasticity lbs. per sq. inch $\times 10^4$                                       | 10-15   | 10-45              | 7-12               | 5-20  | 5-15                  | —                   | 5-15                           | 10-25                 |
| Compressive Strength, lbs. per sq. inch   | 16000-36000   | 18000-36000        | 20000-32000        | 20000-40000                                   | 20000-44000           | 18000-40000         | 15000-30000                    | 28000-36000           |
| Flexural Strength, lbs. per sq. inch  | 8000-15000  | 8000-20000         | 10000-13000        | 13000-20000                                   | 13000-20000           | 17000               | —                              | 10000-16000           |
| Impact Strength, ft. lbs. ASTM D256-34T<br>C = Charpy, I = Izod, N = notched, U = unnotched | 0.10-0.28<br>I, N   | 0.11-0.36<br>I, N  | 0.4-2.4<br>I, N    | 0.4-1.2<br>I, N                               | 0.8-5.2<br>I, N       | —                   | 0.1-1.5<br>I, N                | 0.08-0.5<br>C, N      |
| Hardness (2.5 mm. ball, 25 kg. load), Brinell No.   | 30-45   | —                  | —                  | 24-40   | 30-45                 | —                   | 30-45                          | 35-40 (50)            |
| Thermal Conductivity $10^{-4}$ cal. per sec. per sq. cm./1° C. per cm.                      | 4-12.2  | 8-20               | 3-5                | 5-8   | 5-8                   | —                   | 3-5                            | 3.5-5                 |
| Specific Heat, cal. per ° C. per gram   | 0.35-0.36   | 0.25-0.35          | 0.30-0.35          | 0.3-0.4                                       | 0.3-0.4               | —                   | 0.3-0.4                        | 0.3-0.4               |
| Thermal expansion, $10^{-4}$ per ° C.   | 3.7-7.5   | 2.5-4              | 2-6                | 2   | 3                     | 2                   | 2.8                            | 3                     |
| Resistance to Heat, ° F. (continuous)   | 350   | 450                | 250-350            | 212-300                                       | 212-350               | 400-500             | 160                            | 280-400               |
| Softening Point, ° F.   | None  | None               | None               | None  | None                  | None                | —                              | Chars 45              |
| Distortion under Heat, ° F.   | 240-285   | —                  | —                  | >320  | —                     | —                   | —                              | 268-288               |
| Tendency to Cold Flow   | None  | None               | None               | None  | None                  | None                | —                              | None                  |
| Volume Resistivity, ohm.-cms. (50% relative humidity)                                       | $10^{14}$ - $10^{15}$   | $10^4$ - $10^{11}$ | $10^4$ - $10^{11}$ | $10^{14}$ - $10^{15}$                         | $10^{14}$ - $10^{15}$ | —                   | $10^4$ - $10^{11}$             | $10^{14}$ - $10^{15}$ |
| Breakdown Voltage, 60 cycles, volts per mil (instantaneous)                                 | 300-500   | 250-400            | 300-450            | 400-1300                                      | 150-600               | 90                  | 300-450                        | 400-600               |
| Dielectric Constant, 60 cycles  | 5-12  | 5-20               | 5-10               | —   | —                     | —                   | 5-10                           | —                     |
| Dielectric Constant, $10^3$ cycles  | 4-8   | 4.5-20             | 4.5-6              | —   | —                     | —                   | —                              | 4-8                   |
| Dielectric Constant, $10^6$ cycles  | 4.5-8   | 4.5-20             | 4.5-6              | 4-6   | 4.5-7                 | —                   | 5-7                            | 6-7.5                 |
| Power Factor, 60 cycles   | 0.04-0.30   | 0.10-0.30          | 0.08-0.30          | —   | —                     | —                   | 0.025-0.20                     | —                     |
| Power Factor, $10^3$ cycles   | 0.04-0.15   | 0.10-0.15          | 0.08-0.20          | —   | —                     | —                   | 0.005-0.08                     | 0.04-0.15             |
| Power Factor, $10^6$ cycles   | 0.035-0.1   | 0.005-0.10         | 0.04-0.10          | 0.02-0.05                                     | 0.02-0.08             | —                   | 0.01-0.045                     | 0.035-0.1             |
| Water Absorption, immersion—24 hrs. ASTM D48-33   | 0.2-0.6   | 0.01-0.3           | 1.0-1.3            | 0.5-9.0                                       | 0.5-9.0               | 0.5                 | 0.01-0.5                       | 0.2-0.6               |
| Burning Rate  | Very low  | Nil                | Approx. nil        | Very low                                      | Very low              | Approx. nil         | Very low                       | Very low              |
| Effect of Age   | None  | —                  | —                  | Improves mechanical and electrical properties |                       |                     | Hardens slightly               | —                     |
| Effect of Sunlight  | Light shades discolor   |                    |                    | Lowers surface resistance                     |                       |                     | Colors may fade                | Light                 |
| Effect of Weak Acids  | None to slight depending on acid                                    |                    |                    | —   | —                     | —                   | —                              | —                     |
| Effect of Strong Acids  | Decomposed by oxidizing acids; reducing and organic acids no effect |                    |                    | —   | —                     | —                   | —                              | —                     |
| Effect of Weak Alkalies   | Slight to marked depending on alkalinity                            |                    |                    | —   | —                     | —                   | —                              | —                     |
| Effect of Strong Alkalies   | Decomposed  |                    |                    | —   | —                     | —                   | —                              | —                     |
| Effect of Organic Solvents  | None on bleed-proof materials                                       |                    |                    | —   | —                     | —                   | None                           | —                     |
| Effect on Metal Inserts   | Inert   |                    |                    | —   | —                     | —                   | —                              | —                     |
| Machining Qualities   | Fair to good  | —                  | —                  | Fair to excellent                             |                       |                     | Excellent                      | Fair to good          |
| Clarity   | Opaque  | —                  | —                  | —   | —                     | —                   | Transparent translucent opaque | Opaque                |
| Color Possibilities   | Limited   | —                  | —                  | —   | —                     | —                   | Unlimited                      | Limited               |

# PLASTICS PROPERTIES

upon maximum and minimum figures submitted by a number of manufacturers of each type. Special grades of materials are often available which excel in one particular property. To obtain a list of these materials, a list giving trade names and addresses for each of these chemical types.

| Cast                               | PHENOL-FURFURAL COMPOUNDS          |                                    |                        | UREA-FORMALDEHYDE COMPOUND     | VINYL CHLORIDE-ACETATE RESINS  |  | METHYL METHACRYLATE RESIN            | STYRENE RESIN                      | SHELLAC COMPOUND          |
|------------------------------------|------------------------------------|------------------------------------|------------------------|--------------------------------|--|--|--------------------------------------|------------------------------------|---------------------------|
|                                    | Woodflour Filler                   | Mineral Filler                     | Fabric Filler          | Alpha Cellulose Filler         | Unfilled   | Filled   | Excellent                            | Good                               | Good                      |
| —                                  | Excellent                          | Excellent                          | Good to fair           | Excellent                      | Good   | Excellent  | Excellent                            | Good                               | Good                      |
| —                                  | 330-400                            | 330-360                            | 300-360                | 290-325                        | 240-275  | 250-300  | 285-315                              | 280-325                            | 240                       |
| —                                  | 1000-3000                          | 1000-3000                          | 1000-3000              | 1500-6000                      | 1500-2000  | 2000-2500  | 1500-5000                            | 300-2000                           | 1000-1200                 |
| —                                  | 250-350                            | 250-290                            | 250-290                | —                              | —  | —  | 325-475                              | 300-375                            | —                         |
| —                                  | 300-5000                           | 300-5000                           | 300-5000               | —                              | —  | —  | 3000-30000                           | 3000-30000                         | —                         |
| —                                  | 2.5-3.0                            | 2.5-6.0                            | 4.0-15.0               | 3                              | 2.0  | 1.5-3.5  | 2                                    | 2.5                                | —                         |
| —                                  | 0.005-0.009                        | 0.002-0.006                        | 0.0025-0.006           | 0.007-0.011                    | 0.001  | 0.000  | 0.002-0.003                          | 0.002-0.0025                       | 0.002                     |
| 0.27-1.32                          | 1.3-1.4                            | 1.6-2.0                            | 1.3-1.4                | 1.48-1.50                      | 1.34-1.36  | 1.35-2.5   | 1.18                                 | 1.05-1.07                          | 1.1-2.7                   |
| 1.8-20.0                           | 21.3-19.8                          | 17.3-13.9                          | 21.3-19.8              | 18.7-18.5                      | 20.7-20.4  | 20.5-11.1  | 23.3                                 | 26.3-25.8                          | 25.2-10.3                 |
| 1.5-1.7                            | —                                  | —                                  | —                      | 1.54-1.6                       | 1.53   | —  | 1.49                                 | 1.67                               | —                         |
| 50-12000                           | 5000-12000                         | 4000-12000                         | 5000-10000             | 8000-13000                     | 8000-10000   | 6000-12000   | 7000-9000                            | 5500-7500                          | 900-2000                  |
| —                                  | —                                  | —                                  | —                      | —                              | —  | —  | <1.0                                 | 1.0                                | —                         |
| 5-15                               | 10-25                              | 10-45                              | 7-12                   | 16                             | 3.5-4.1  | 3.5-8.5  | 6                                    | 4.6-5.1                            | —                         |
| 300-30000                          | 28000-36000                        | 24000-36000                        | 26000-30000            | 24000-35000                    | —  | —  | 8000                                 | 13000-13500                        | —                         |
| —                                  | 10000-16000                        | 8000-14000                         | 10000-16000            | 13000-15000                    | 10000-13000  | —  | 15000-17000                          | 6500-8000                          | —                         |
| 0.1-1.5<br>I, N                    | 0.08-0.52<br>C, N                  | 0.08-0.48<br>C, N                  | 1.6-3.1<br>C, N        | 0.7-1.5<br>C, U                | 0.3-0.6<br>I, N  | 0.1-0.7<br>I, N                                      | 0.25-0.5<br>C, N                     | 0.16-0.25<br>I, N                  | —                         |
| 30-45                              | 35-40 (50 kg.)                     | 44-46<br>(50 kg.)                  | 30-35<br>(50 kg.)      | 48-54<br>(500 kg., 10 mm.)     | 15-25  | 15-25  | 18-20<br>(500 kg., 10 mm.)           | 20-30                              | —                         |
| 3-5                                | 3.5-5                              | 10-30                              | 5-8                    | 7.13                           | 4.0  | Varies   | 4.3-6.8                              | 1.9                                | —                         |
| 0.3-0.4                            | 0.3-0.4                            | 0.3-0.4                            | 0.3-0.4                | —                              | 0.244  | Varies   | 0.45                                 | 0.324                              | —                         |
| 2.8                                | 3                                  | 2                                  | 4.5                    | 1.5                            | 6.9  | Varies   | 8.5                                  | 10.2                               | —                         |
| 160                                | 280-400                            | 350-500                            | 280-350                | 160                            | —  | —  | —                                    | —                                  | 150-190                   |
| —                                  | Chars 450                          | Chars 550                          | Chars 400              | None                           | 130-160  | 130-160  | 170-235                              | 110-200                            | 150                       |
| —                                  | 268-288                            | 277-297                            | —                      | 260                            | 140-150  | 140-150  | 150                                  | 185                                | —                         |
| —                                  | None                               | None                               | None                   | None                           | Slight   | Slight   | Slight                               | Slight                             | Slight                    |
| 10 <sup>10</sup> -10 <sup>11</sup> | 10 <sup>10</sup> -10 <sup>11</sup> | 10 <sup>10</sup> -10 <sup>11</sup> | 0.4 × 10 <sup>11</sup> | (3-2.8) × 10 <sup>11</sup>     | >10 <sup>11</sup>  | 10 <sup>11</sup>                                     | >10 <sup>11</sup>                    | 10 <sup>10</sup> -10 <sup>11</sup> | —                         |
| 360-450                            | 400-600                            | 200-500                            | 200-500                | 650-720                        | 400-500  | 350-400  | 480                                  | 500-700                            | 100-400                   |
| 5-10                               | —                                  | —                                  | —                      | 6.6                            | —  | —  | 4-6                                  | 2.6                                | —                         |
| —                                  | 4-8                                | 4.5-20                             | 4.5-6                  | —                              | —  | 4.7  | —                                    | 2.65                               | —                         |
| 5-7                                | 6-7.5                              | 5-18                               | 5-7.5                  | 6                              | 4  | 4  | 2.8                                  | 2.70                               | —                         |
| 0.025-0.30                         | —                                  | —                                  | —                      | 0.034                          | —  | —  | 0.06-0.08                            | 0.0003                             | —                         |
| 0.05-0.06                          | 0.04-0.15                          | 0.1-0.15                           | 0.08-0.20              | —                              | 0.0143   | 0.02-0.15  | —                                    | <0.0001                            | —                         |
| 0.1-0.045                          | 0.035-0.1                          | 0.04-0.1                           | 0.035-0.1              | 0.01-0.03                      | 0.0175   | 0.02-0.065   | 0.02                                 | <0.0001                            | —                         |
| 0.01-0.5                           | 0.2-0.6                            | 0.01-0.15                          | 0.3-1.4                | 1-2                            | 0.05-0.15  | 0.2-4.0  | 0.3                                  | 0.00                               | —                         |
| Very low                           | Very low                           | Nil                                | Nil                    | Very low                       | Nil  | Approx. nil  | Slow                                 | Slow                               | High (wood filler)        |
| Hardens slightly                   | ←                                  | ←                                  | ←                      | ←                              | Strength unaffected  | None   | ←                                    | ←                                  | —                         |
| Colors may fade                    | Light shades discolor              |                                    |                        | None                           | Darkens  | Discolors  | None                                 | Yellows                            | None                      |
| ←                                  | ←                                  | ←                                  | ←                      | ←                              | Resistant  | Dependent on filler                                  | None                                 | ←                                  | Deteriorates              |
| ←                                  | ←                                  | ←                                  | ←                      | Decomposed or surface attacked | Resistant  | Dependent on filler                                  | Oxidizing acids attack surface       | None                               | Deteriorates              |
| ←                                  | ←                                  | ←                                  | ←                      | ←                              | Resistant  | Dependent on filler                                  | None                                 | ←                                  | Deteriorates              |
| ←                                  | ←                                  | ←                                  | ←                      | ←                              | Resistant  | Dependent on filler                                  | Slight                               | None                               | Deteriorates              |
| None                               | ←                                  | ←                                  | ←                      | ←                              | Resists alcohols, aliphatic hydrocarbons, and oils. Soluble in ketones and esters; swells in aromatic hydrocarbons | Soluble in ketones, esters and aromatic hydrocarbons | Widely soluble                       | Attacked by some                   | —                         |
| ←                                  | ←                                  | ←                                  | ←                      | ←                              | Not used   | Inert  | —                                    | —                                  | Inert                     |
| Excellent                          | Fair to good                       | ←                                  | ←                      | Fair                           | Good   | Excellent (organic filler)                           | Very good                            | Poor to good                       | ←                         |
| Transparent translucent opaque     | Opaque                             | ←                                  | ←                      | Translucent opaque             | Transparent translucent opaque   | ←  | Transparent (95% light) transmission | Transparent translucent opaque     | Opaque                    |
| Unlimited                          | Limited                            | ←                                  | ←                      | Unlimited; pastel shades       | Unlimited, pastels to black  | ←  | Unlimited                            | ←                                  | Limited; pastels excluded |

To know →

# PROPERTIES CHART

Properties of each type of plastic material. Differences in test procedures and sizes of test specimens may be noted. The manufacturers should always be consulted before making a choice of material. In order to facilitate selection, a chart of the chemical types of plastics has been prepared and will be found on pages in the Directory Section.

| PLASTIC          | SHELLAC COMPOUND          | COLD MOLDED              |                        | RUBBER COMPOUNDS                 |                            |  | CASEIN             | Ethyl-cellulose                | CELLULOSE COMPOUNDS  |                              |
|------------------|---------------------------|--------------------------|------------------------|----------------------------------|----------------------------|--|--------------------|--------------------------------|--|------------------------------|
|                  |                           | Non-Refractory (Organic) | Refractory (Inorganic) | Chlorinated Rubber               | Modified Isomerized Rubber | Hard Rubber                            |                    |                                | Sheet  | Molding                      |
| Good             | Good                      | Fair                     | Fair                   | Fair                             | Good                       | Fair                                   | Poor               | Excellent                      | Excellent  | Excellent                    |
| 325              | 240                       | —                        | —                      | 200-225                          | 260-300                    | 285-350                                | 200-225            | 212-300                        | 210-320  | 250-350                      |
| 2000             | 1000-1200                 | 4000-12000               | 4000-12000             | 2000-5000                        | 1200-4000                  | 1200-1800                              | 2000-2500          | 1000-5000                      | 500-5000   | 500-5000                     |
| 375              | —                         | —                        | —                      | —                                | —                          | 180-220                                | —                  | —                              | —  | 300-440                      |
| 30000            | —                         | —                        | —                      | —                                | —                          | 2000-5000                              | —                  | —                              | —  | 3000-30000                   |
| 5                | —                         | 2.5                      | 3.5                    | 2-3                              | 3                          | 4-6                                    | —                  | 2.2-2.9                        | —  | 2-2.8                        |
| 0.0025           | 0.002                     | 0.000-0.022              | 0.000                  | —                                | 0.000                      | —                                      | —                  | 0.0003-0.0007                  | Positive and injection 0.002-0.003 Semi-positive 0.005-0.007 Flash 0.008-0.009       |                              |
| 1.07             | 1.1-2.7                   | 1.98-2.00                | 2.20                   | 1.5                              | 1.06                       | 1.12-1.80                              | 1.35               | 1.14                           | 1.27-1.37  | 1.27-1.63                    |
| 25.8             | 25.2-10.3                 | 14.0-13.9                | 12.6                   | 18.5                             | 26.1                       | 24.7-15.4                              | 20.5               | 24.3                           | 21.8-20.2  | 21.8-17.0                    |
| 67               | —                         | —                        | —                      | 1.56                             | —                          | —                                      | —                  | 1.470                          | 1.49-1.50  | 1.47-1.50                    |
| 7500             | 900-2000                  | —                        | —                      | —                                | 4300                       | 4000-10000                             | 7600               | 2000-7000                      | 6000-11000   | 3500-10000                   |
| 0                | —                         | —                        | —                      | —                                | 0.013                      | 8-15                                   | —                  | —                              | 20-55  | 10-48                        |
| 5.1              | —                         | —                        | —                      | —                                | 4.7                        | 5.3                                    | 5.1-5.7            | 2.8                            | 1-3  | 2-4                          |
| 13500            | —                         | 6000-15000               | 16000                  | —                                | 8500-11000                 | 8000-12000                             | —                  | —                              | 4000-16000   | 11000-16000                  |
| 8000             | —                         | 5300-7500                | 6000                   | —                                | 7000-9000                  | —                                      | —                  | —                              | —  | 5200-8800                    |
| 0.25 N           | —                         | 0.4 C                    | 0.4 C                  | 3.0+ C, U                        | 2.6-6.2 I, N               | 0.5 I                                  | 1.0 I              | 1-4 I, N (per inch sq.)        | 2-7 C, N (per inch sq.)  | 3-12 C, N (per inch sq.)     |
| 30               | —                         | —                        | —                      | —                                | 85-90 (Shore)              | 31                                     | 23                 | —                              | 6-11 (10 kg.)  | 6-7.5 (10 kg.)               |
| 9                | —                         | —                        | —                      | —                                | 2.6-2.9                    | 3.2                                    | —                  | —                              | 5.4-8.7  | 5.4-8.7                      |
| 324              | —                         | —                        | —                      | —                                | —                          | 0.33                                   | —                  | —                              | 0.3-0.4  | 0.3-0.45                     |
| 0.2              | —                         | —                        | —                      | —                                | 7-8                        | 8.0                                    | 8                  | —                              | 14-16  | 14-16                        |
| 150-190          | —                         | 500                      | 1300                   | —                                | —                          | —                                      | —                  | —                              | 140-180  | 140-180                      |
| 200              | 150                       | —                        | —                      | 175-230                          | 165-220                    | 150-190                                | 200                | 210-266                        | 140-230  | 145-260                      |
| 85               | —                         | —                        | —                      | 140                              | 167-221                    | —                                      | —                  | —                              | 122-212  | 122-212                      |
| light            | Slight                    | —                        | —                      | Slight                           | Slight                     | Slight                                 | —                  | —                              | Slight   | Slight                       |
| 10 <sup>11</sup> | —                         | 1.3 × 10 <sup>11</sup>   | —                      | —                                | (5-7) × 10 <sup>11</sup>   | 10 <sup>11</sup> -10 <sup>12</sup>     | —                  | —                              | (5-30) × 10 <sup>11</sup>  | (4.2-6.2) × 10 <sup>11</sup> |
| 700              | 100-400                   | 85                       | —                      | 2300                             | —                          | 250-900                                | 400-700            | 1500                           | 800-2500   | 800-850                      |
| 6                | —                         | 15.0                     | —                      | ca. 3                            | 2.7                        | 2.8                                    | —                  | —                              | 5.1-7.5  | 5.8-6.0                      |
| 65               | —                         | —                        | —                      | —                                | 2.68                       | —                                      | —                  | 3.72                           | —  | —                            |
| 70               | —                         | 6.0                      | —                      | —                                | —                          | 3                                      | 6.15-6.8           | —                              | 4.2-5.3  | 4.4-4.6                      |
| 003              | —                         | 0.20                     | —                      | 0.003                            | 0.006                      | —                                      | —                  | —                              | 0.025-0.07   | 0.042-0.058                  |
| 001              | —                         | —                        | —                      | —                                | —                          | —                                      | —                  | 0.011                          | —  | —                            |
| 001              | —                         | 0.07                     | —                      | —                                | 0.0016                     | 0.003-0.008                            | 0.052              | —                              | 0.038-0.091  | 0.038-0.042                  |
| 00               | —                         | 1.5                      | 0.5-15                 | 0.1-0.3                          | 0.02                       | 0.02                                   | 3-7                | 1.25 (48 hrs.)                 | 1.5-3.0  | 1.4-2.8                      |
| low              | High (wood filler)        | Nil                      | Nil                    | Nil                              | Slow                       | Medium                                 | Very low           | Slow                           | Slow   | Slow                         |
| —                | —                         | —                        | —                      | Slight embrittlement             | None                       | ←                                      | Hardens slightly   | Slight                         | ←  | ←                            |
| ows              | None                      | —                        | —                      | Darkens                          | Slight surface crazing     | Discolor; surface reactivity decreases | Colors may fade    | Slight                         | ←  | ←                            |
| —                | Deteriorates              | Slight                   | Decomposes             | Resistant                        | ←                          | ←                                      | ←                  | Slight                         | ←  | ←                            |
| ne               | Deteriorates              | Decomposes               | ←                      | Resistant                        | ←                          | Attacked by oxidizing acids            | Decomposes         | ←                              | ←  | ←                            |
| —                | Deteriorates              | Decomposes               | None                   | Resistant                        | ←                          | ←                                      | Softens            | None                           | Slight   | ←                            |
| no               | Deteriorates              | Decomposes               | None                   | Resistant                        | ←                          | ←                                      | Decomposes         | None                           | Decomposes   | ←                            |
| ely ible         | Attacked by some          | ←                        | None                   | Soluble in aromatic hydrocarbons | Attacked by some           | ←                                      | Resistant          | Widely soluble                 | Soluble in ketones and esters; softened by alcohols; little affected by hydrocarbons |                              |
| —                | Inert                     | ←                        | ←                      | —                                | Inert                      | —                                      | —                  | Inert                          | ←  | ←                            |
| r to od          | ←                         | Poor                     | ←                      | —                                | Good                       | Fair                                   | Good               | ←                              | ←  | ←                            |
| parent uent ue   | Opaque                    | ←                        | ←                      | Translucent opaque               | Transparent                | Opaque                                 | Translucent opaque | Transparent translucent opaque | ←  | ←                            |
| —                | Limited; pastels excluded | Dark colors only         | Gray                   | Unlimited                        | ←                          | Limited                                | Unlimited          | ←                              | ←  | ←                            |

Small copies of this Chart are available at 50¢ each. Address MODERN PLASTICS

and sizes of test specimens may lead to erroneous conclusions in making a choice of material. In order to facilitate pages in the Directory Section

| CELLULOSE COMPOUNDS |  |                              |                                  | PROPERTIES  |
|---------------------|--|------------------------------|----------------------------------|---|
| Cellulose           | Cellulose Acetate  |                              | Cellulose Nitrate (Pyroxylin)    |   |
|                     | Sheet  | Molding                      |                                  |   |
| Test                | Excellent  | Excellent                    | Good                             | Molding Qualities   |
| 300                 | 210-320  | 250-350                      | 185-250                          | Compression Molding Temp., ° F.   |
| 5000                | 500-5000   | 500-5000                     | 2000-5000                        | Compression Molding Pressure, lbs. per sq. inch   |
|                     | —  | 300-440                      | —                                | Injection Molding Temp., ° F.   |
|                     | —  | 3000-30000                   | —                                | Injection Molding Pressure, lbs. per sq. inch   |
| 1.9                 | —  | 2-2.8                        | —                                | Compression Ratio   |
| 0.0007              | Positive and Injection 0.005-0.008 Semi-positive 0.006-0.007 Flash 0.006-0.009             |                              | —                                | Mold Shrinkage, inches per inch   |
| 4                   | 1.27-1.37  | 1.27-1.63                    | 1.35-1.60                        | Specific Gravity  |
| 3                   | 21.8-20.2  | 21.8-17.0                    | 20.5-17.3                        | Specific Volume, cubic inch per lb.   |
| 70                  | 1.49-1.50  | 1.47-1.50                    | 1.50                             | Refractive Index, N <sub>D</sub>  |
| 7000                | 6000-11000   | 3500-10000                   | 5000-10000                       | Tensile Strength, lbs. per sq. inch   |
|                     | 20-55  | 10-48                        | 10-40                            | Elongation, %   |
| 8                   | 1-3  | 2-4                          | 2-4                              | Modulus of Elasticity, lbs. per sq. inch × 10 <sup>4</sup>  |
|                     | 4000-16000   | 11000-16000                  | —                                | Compressive Strength, lbs. per sq. inch   |
|                     | —  | 5200-8800                    | —                                | Flexural Strength, lbs. per sq. in. h   |
| 1 inch sq.)         | 2-7<br>C, N (per inch sq.)   | 3-12<br>C, N (per inch sq.)  | 3-12<br>C, N (per inch sq.)      | Impact Strength, ft. lbs.<br>ASTM D256-34T<br>C = Charpy, I = Izod,<br>N = notched, U = unnotched |
|                     | 6-11<br>(10 kg.)   | 6-7.5<br>(10 kg.)            | 8-11<br>(10 kg.)                 | Hardness (2.5 mm. ball, 2.5 kg. load),<br>Brinell No.   |
|                     | 5.4-8.7  | 5.4-8.7                      | 3.1-5.1                          | Thermal Conductivity, 10 <sup>-4</sup> cal. per sec.<br>per sq. cm./1° C. per cm.                 |
|                     | 0.3-0.4  | 0.3-0.45                     | 0.34-0.38                        | Specific Heat, cal. per ° C. per gram   |
|                     | 14-16  | 14-16                        | 12-16                            | Thermal Expansion, 10 <sup>-6</sup> per ° C.  |
|                     | 140-180  | 140-180                      | ca. 140                          | Resistance to Heat, ° F. (continuous)   |
| 166                 | 140-230  | 145-260                      | 160-195                          | Softening Point, ° F.   |
|                     | 123-212  | 123-212                      | —                                | Distortion under Heat, ° F.   |
|                     | Slight   | Slight                       | —                                | Tendency to Cold Flow   |
|                     | (5-30) × 10 <sup>11</sup>  | (4.2-6.2) × 10 <sup>11</sup> | (2-30) × 10 <sup>10</sup>        | Volume Resistivity, ohm.-cms.<br>(50% relative humidity)  |
| 90                  | 800-2500   | 800-850                      | 600-1200                         | Breakdown Voltage, 60 cycles,<br>volts per mil (instantaneous)                                    |
|                     | 5.1-7.5  | 5.8-6.0                      | 6.7-7.3                          | Dielectric Constant, 60 cycles  |
| 2                   | —  | —                            | —                                | Dielectric Constant, 10 <sup>3</sup> cycles   |
|                     | 4.2-5.3  | 4.4-4.6                      | 6.15                             | Dielectric Constant, 10 <sup>4</sup> cycles   |
|                     | 0.025-0.07   | 0.042-0.058                  | 0.062-0.144                      | Power Factor, 60 cycles   |
| 11                  | —  | —                            | —                                | Power Factor, 10 <sup>3</sup> cycles  |
|                     | 0.038-0.091  | 0.038-0.042                  | 0.074-0.097                      | Power Factor, 10 <sup>4</sup> cycles  |
| 18 hrs.)            | 1.5-3.0  | 1.4-2.8                      | 1.0-3.0                          | Water Absorption, immersion—24 hrs.<br>ASTM D48-33  |
| w                   | Slow   | Slow                         | Very high                        | Burning Rate  |
| ht                  | ←  | ←                            | Slight<br>hardening              | Effect of Age   |
| ht                  | ←  | ←                            | Discolors and<br>becomes brittle | Effect of Sunlight  |
| ht                  | ←  | ←                            | ←                                | Effect of Weak Acids  |
|                     | ←  | ←                            | ←                                | Effect of Strong Acids  |
| ne                  | Slight   | ←                            | ←                                | Effect of Weak Alkalies   |
| ne                  | Decomposes   | ←                            | ←                                | Effect of Strong Alkalies   |
| ely<br>ble          | Soluble in ketones and esters;<br>softened by alcohols;<br>little affected by hydrocarbons |                              | ←                                | Effect of Organic Solvents  |
| rt                  | ←  | ←                            | —                                | Effect on Metal Inserts   |
|                     | ←  | ←                            | ←                                | Machining Qualities   |
| arent<br>cent<br>ue | ←  | ←                            | ←                                | Clarity   |
|                     | ←  | ←                            | ←                                | Color Possibilities   |

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# MOLDING AND FABRICATING

PAGES 121-202

DESIGNING FOR PRODUCTION

MOLD DESIGN

MOLD STEEL

BERYLLIUM COPPER

PREFORMING

COMPRESSION MOLDING

INJECTION MOLDING

COLD MOLDING

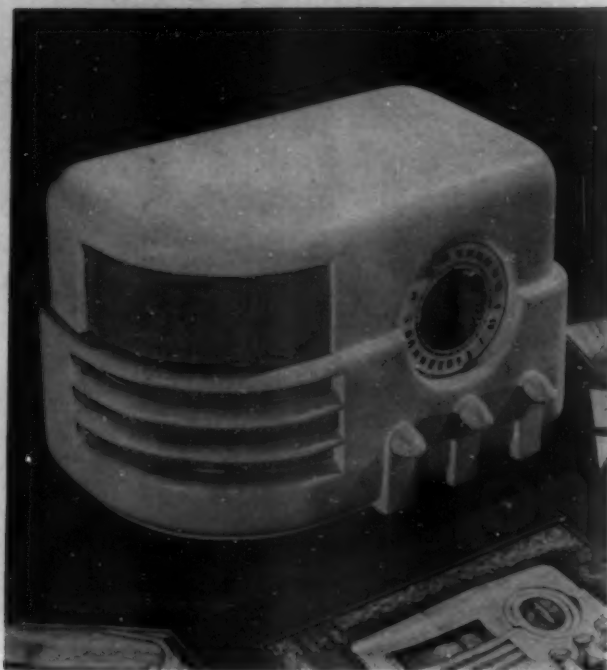
COLOR MOLDING

PRINTING

MOLDING WITH BLANKS

FABRICATING CAST RESINS

FABRICATING THERMOPLASTICS



1. Redesigning the Dunham valve handle as a molded plastic product improved its appearance, did away with machining and finishing operations. 2. A public opinion survey helped to select the design for this Majestic radio. (All photos courtesy Barnes & Reinecke)

## DESIGN DATES YOUR PRODUCT

by J. O. REINECKE

THERE IS HARDLY A PRODUCT IN THE NATION today which hasn't had the benefit of some sort of design consideration. Perhaps "benefit" is not the right word, because through lack of experience or disregard of obvious facts many products are "designed" not to sell. The point is that all industry has become conscious of the necessity for design and manufacturers throughout the country are proving its value day after day by sales and profit especially where plastics are used.

By design I mean not only appearance, but also the closely interwoven and interdependent elements, namely, engineering, appearance, merchandising, adaptability, utility and desirability. As industrial design is useful only to facilitate distribution of manufactured products, plastics as materials become an element of design. Their inherent qualities are such that they contribute much to the aforementioned factors. Very often the multiple functions of plastics simplify construction and eliminate parts, resulting in reduced costs.

However, the manner in which they are used must be controlled by design because they cannot rely entirely on their properties, lest they be overshadowed by products well designed in other materials. Improper design for plastics may nullify their natural advantages. That design is valuable may be accepted as a fact, but to become

important to you, its value must be determined as applied to your specific product.

There is a distinct difference between *cost* and *value*. The amount which may be spent on design can easily be established as a percentage of the production cost, but the true value must be gaged entirely by its effects.

Let us first consider design as a protection.

You are paying large premiums for insurance for protection against death, accident, fire and theft, but so far no policies have been written to safeguard you against the ever changing demands of the public. Your only protection against the loss of sales is through the use of intelligent design.

Your first production investment is in the mold itself; its production requires a great amount of time and represents a substantial investment. The time and effort expended on making a mold for a poorly designed product is just as great as for a product with appeal, but without the eventual sales possibilities to justify the outlay. In this same category are the tools and dies for other parts used in the product.

Next comes the investment behind the product—the working capital required, cost of factory and manufacturing facilities, salaries and wages. Your actual sales costs, such as advertising, commissions and other sell-

ing expenses must be included as a risk to be covered.

Another item to be protected is the intangible institutional prestige. Adverse reflection cast by a poor product upon the organization and its other products can be damaging even after the offending article has been removed from the line.

Although the protection afforded by design is important, it is not the only benefit to be derived. One of the contingencies which every manufacturer must face is the constant changing of tastes and outmoding of designs, but through the use of intelligent design you are in a position to meet consumer demands and, to some extent, dictate trends.

The greatest value of good design is the dividend expressed in the form of increased sales. In the case histories of dozens of diversified products you will find the same statement reiterated, that attractive design has resulted in added sales and profits. Every manufacturer should know what to expect when he invests in design and I feel that a brief outline might be helpful in judging the merits for yourself.

Your product will be well proportioned in its entirety, as well as its component parts. This is especially necessary when using plastics. The molds, being mechanically formed, are essentially geometric in design, placing emphasis on proportion, and to the resulting simplicity of shape may be attributed a good portion of the appeal of plastic products.

The materials themselves will be selected for their characteristic properties. While plastics are occasionally misused, the qualities such as low temperature conductivity, insulation, variable composition, smooth, lustrous, permanent finish, brilliant colors and versatility have resulted in their rapidly increasing popularity.

Your product will be basically functional in that it will actually perform the duties for which it appears to have been created.

It will create a favorable first impression, inviting further consideration, and be so striking as to warrant preferred display in retail outlets, yet it will be harmonious and adaptable to its surroundings—an article to be "lived with" and a constant advertisement in the hands of a satisfied customer.

Color has come to fill an important role and should be properly used in relationship with the product and its use. The almost unlimited selection of color offered by plastics often warrant their use, but too little thought has been given to the potentialities offered and too little care given to the colors selected.

Akin to color is the combination of material either of different types of plastics, or of plastics combined with other materials for effective harmony or contrast. While many and varied decorative treatments such as stipple, applied decorations, varying planes and pleasing curves are possible, the exclusive use of any one material frequently results in monotony. The textures and colors of other materials complement and enhance plastics when used in combination.

One of the greatest injustices to plastics has been their treatment as an imitation. Perhaps the swiftness with



3



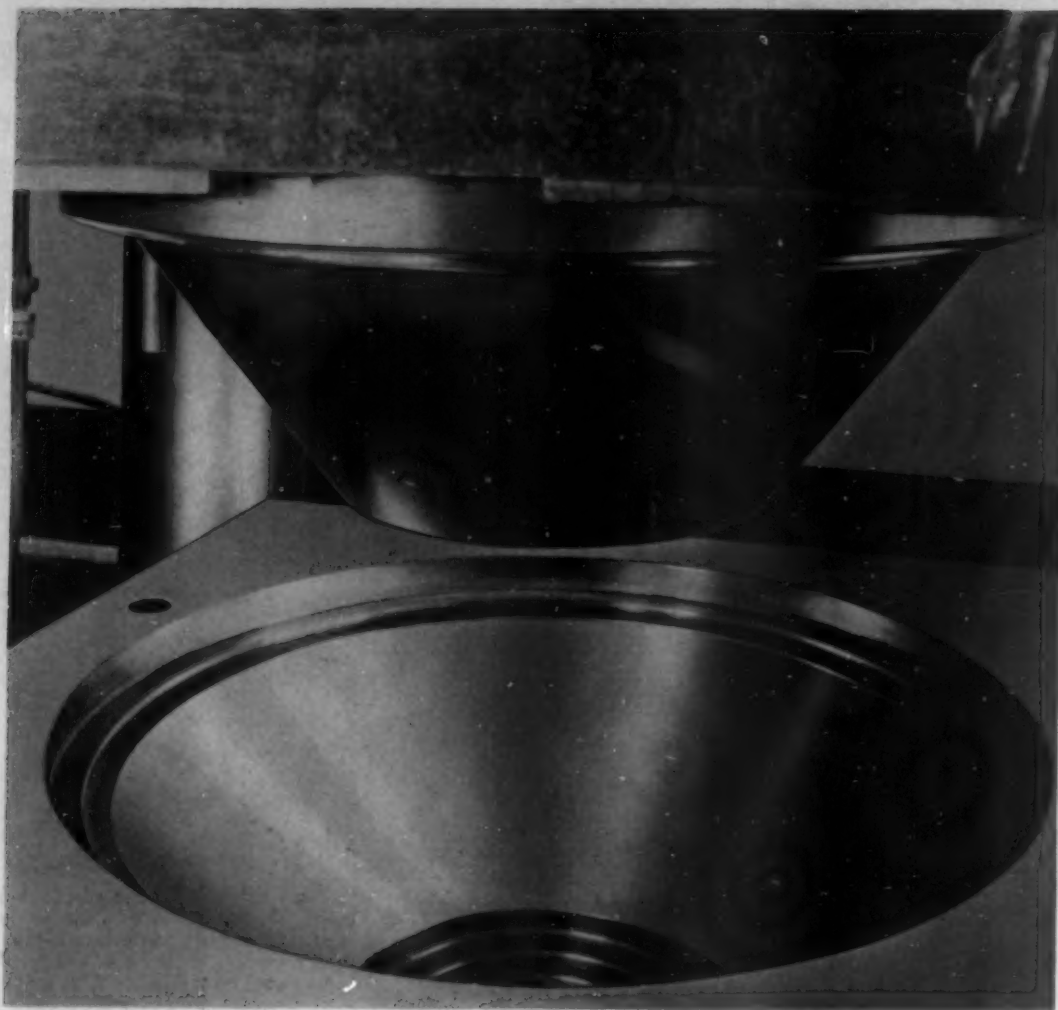
4

3. Rand-McNally uses a plastic stand for their Celestial Globe to improve appearance, and cut cost to one fourth that of the former wooden cradle. 4. Molded plastics are used on the Burton Oculite because of permanent finish and heat insulating value

which they are replacing other materials for specific articles has resulted in retaining a similarity of design created for the former. Their versatility is such that they can closely imitate several other materials, yet they actually are so definitely distinctive that they cannot be simulated by others. The design of a plastic product should be such that it cannot be effectively copied in another material.

Your product will be designed for the future. It must be competitively effective for a period of at least a year after its actual production, which is preceded by the several months required for producing tools and dies following the selection of design. The effectiveness of the design, like the investment it affects, should also be ensured. Methodical and practical procedure backed by thorough research and knowledge cannot be slighted.

A number of good designs may be created for any product; therefore, as many suggestions as possible should comprise the start, from which the *best* is selected. A few tentative selections should be tested for public acceptance. No one person can determine this—the reactions of the designer, manufacturer, jobbers, retailers and public itself should be pooled toward reaching a final selection. Almost inevitably the final choice will be the design which incorporates the many qualities of plastics used to their best advantage.



Looking into the cavity of the 5 ton mold used in forming the new 26½ in. Wakefield reflector. (All photos courtesy General Electric Co.)

## PRACTICAL MOLD DESIGN

by L. S. GLEASON and J. D. MILNE

IN THE PLASTICS INDUSTRY, THE DESIGN AND construction of the molds are of great importance not only to the molder but to the customer as well. Unfortunately, few owners of molds have even seen them, or know, except in a general way, how they operate. There is a very definite relation between the quality of the mold and the molded part which it produces. If the customer is to be assured a continued production of high quality at a commensurate minimum cost, it is necessary to have a mold properly designed and constructed for the particular application on hand. The initial cost of such a mold may be slightly more but to follow any other procedure is a gamble in which both the customer and the molder are losers. An experienced molder knows this for he realizes that maximum production from press

equipment and low maintenance costs are not possible without a mold well designed and constructed. Fig. 1 is a typical mold of the semi-automatic type.

Like all other materials plastics have their limitations and restrictions. These should be known to the designer responsible for the design of the part to be molded. The lack of this knowledge often complicates the design of the mold. Some of the restrictions are due to the actual molding operation which forms and solidifies the materials under pressures from two thousand pounds per square inch upward. All parts of the mold exposed to this pressure must of necessity be strong enough to withstand it. Now, keeping in mind that the mold surface is the reverse of the part it produces, recesses and holes in the molded part, require bosses and pins in the mold,

while projections on the molded part require recesses in the mold. Thus a recess in the molded part cannot be any smaller than a projection of steel in the mold strong enough to withstand the molding pressure. Figs. 2 and 3 are examples of weak mold parts.

All molds for compression molding, except the truly positive type, have butting or cut-off surfaces which are usually located at the greatest periphery of the part to be molded at right angle to the direction of press travel. Over these surfaces the excess material spills and is cut off. Here the greatest pressures are exerted. While with proper mold design and construction the amount of material left between these surfaces can be kept to a minimum, there is always a thin fin of material left which in most cases will remain attached to the molded part. This is called the flash.

It is desirable to have this flash point planned so as to be in the same horizontal plane facilitating the matching of the mold cut-off surfaces. If this flash point is located at the top or bottom edges of the molded part rather than an intermediate point between these edges, the cleaning or removal of the flash is much more readily

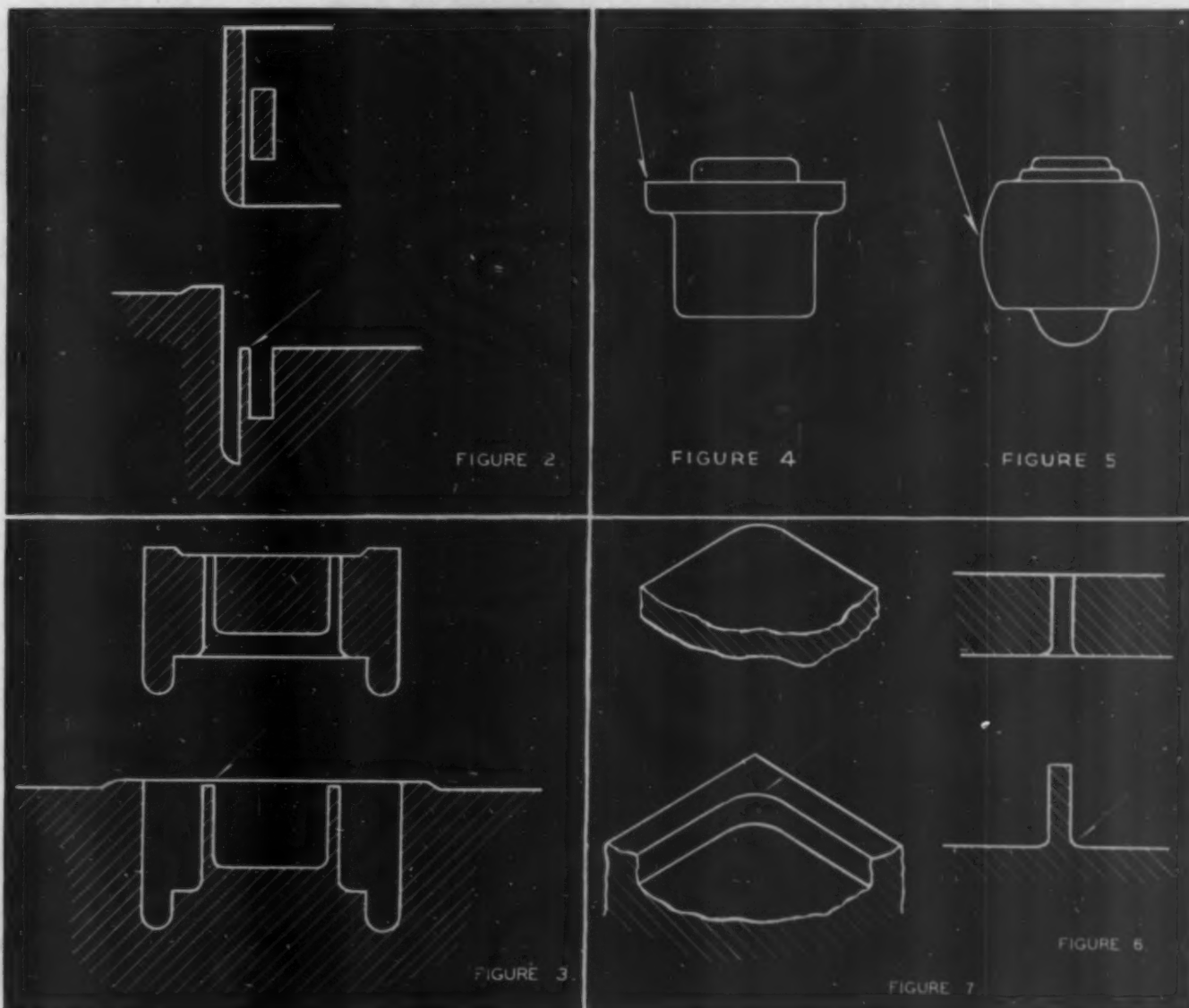
accomplished as well as eliminating the extreme accuracy of line-up between mold members which is almost impossible to maintain. Fig. 4 shows a part with flash point easy to clean. Fig. 5 shows a part with flash point hard to clean.

Projections or bosses on a molded part which call for a depression in the mold should avoid sharp corners that must be dug out with hand tools. If possible the radius formed by the milling cutter, used to cut the depression, should be called for. Where projections join the main body of the mold as generous a radius as possible should be specified to help strengthen the mold part as well as avoid cracking in the subsequent hardening operation. Fig. 6 shows a radius left instead of sharp corners and Fig. 7 shows a fillet to strengthen the mold.

High thin projections (Fig. 2) on the molded part mean deep narrow recesses in the mold which are very often impossible to machine in solid steel. If they cannot be avoided it may be necessary to build the mold part in sections which entails more work and expense.

In designing parts, consider the amount of fine detail called for on the top surfaces (*Continued on page 154*)

2,3. Arrow indicates weak mold section. 4. Arrow shows flash line. 5. Arrow indicates location of a flash line



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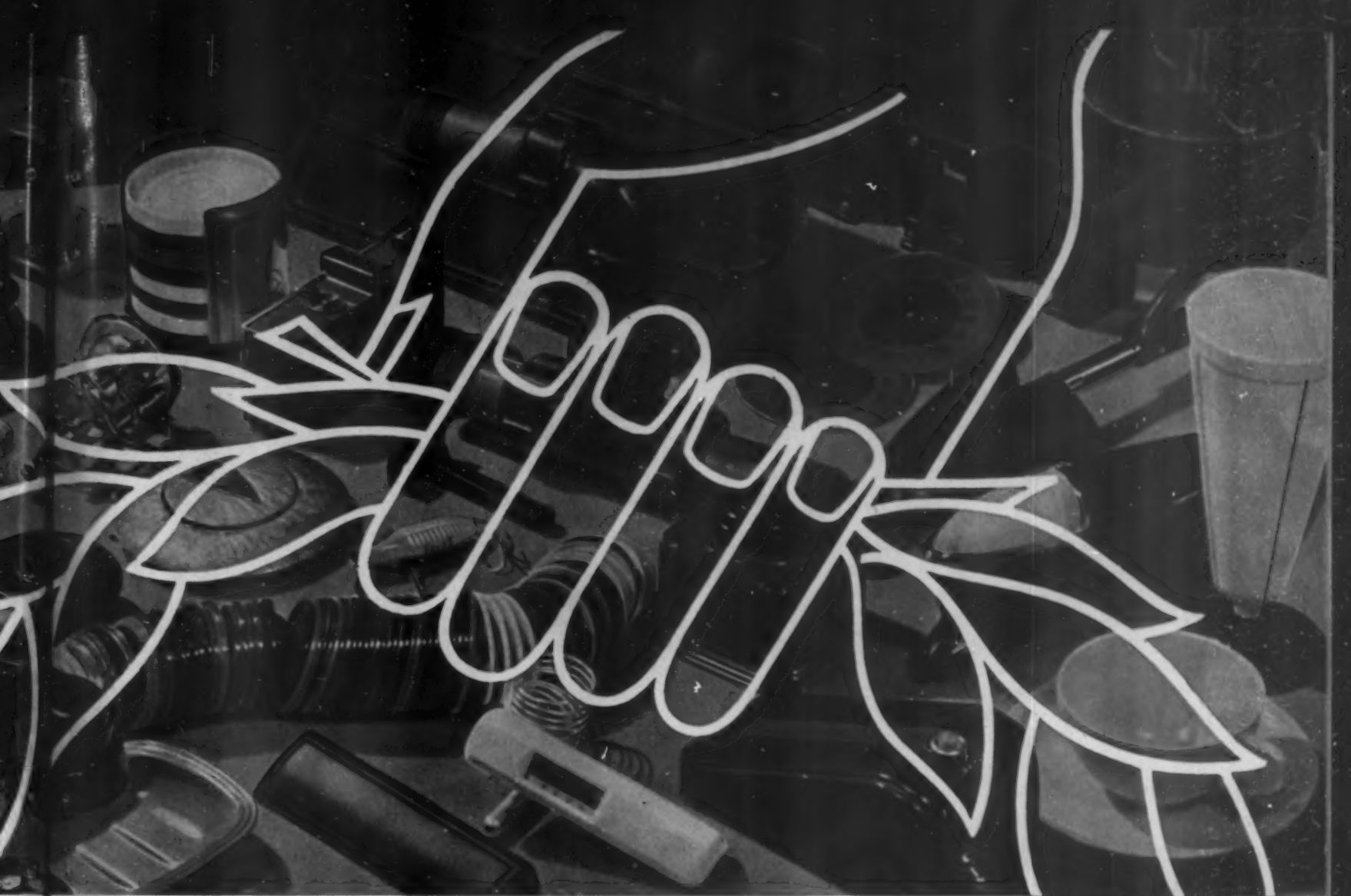
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# MOLD STEEL FOR MOLDED PLASTICS

by FRANK R. PALMER

PLASTIC MATERIALS DERIVED FROM PHENOL, urea, rubber and other bases are molded in steel molds. The molded article depends upon the cavity in the mold not only for its shape but for the perfection of its finish as well. The cost of the mold obviously enters into the cost of the product. As is the case with all tools, mold economy depends upon: (1) How much it costs to make the mold; (2) How much must be spent on its upkeep; (3) How much work it does before it must be scrapped; (4) The quality of the parts made in the mold. (Inspection losses and reclaiming costs.)

Before discussing the steels used for molds, it will be helpful to set down the properties that a good mold steel should have. Here they are: (A) Cleanness; (B) Strength to resist upsetting; (C) Wear resistance; (D) Ease of fabrication: (1) Hobbing, (2) Machining, (3) Heat treating, (4) Polishing.

A. *Cleanness*: This means that the steel should be free from *internal* defects which might appear on the surface of the cavity and mar the finish of the product. Pin holes, hair line cracks, sponginess, slag or any other foreign materials are not only objectionable but expensive. Under operating pressure and temperature, these internal defects tend to open up and leave ridges or imperfections on the surface of the work.

Defects of this character are usually not visible to the eye on a machined or sawed surface. They often become visible only on the highly polished surface of the

finished mold—or appear after it has been put into service.

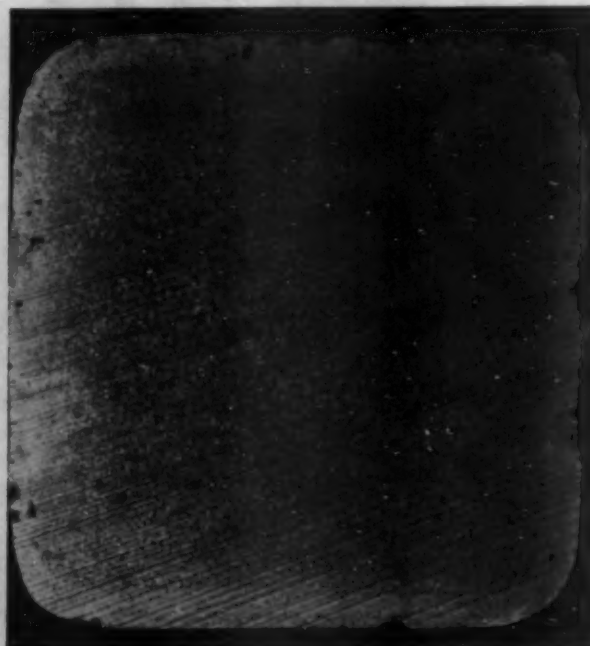
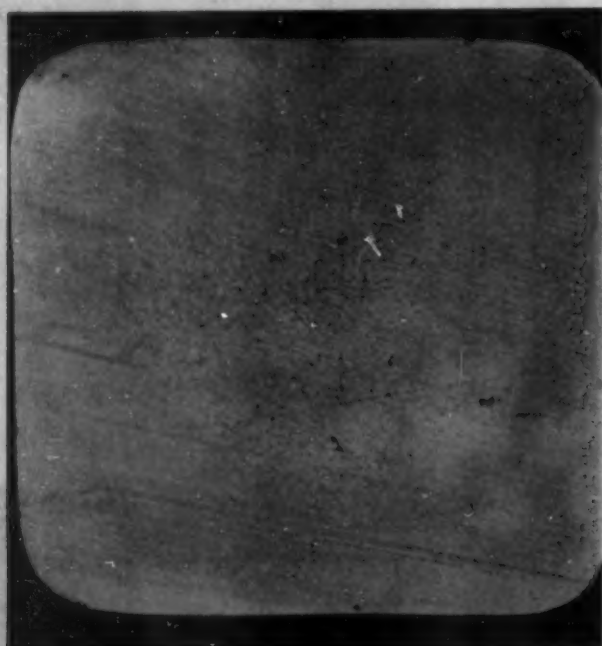
The best inspection for cleanness is the hot acid etch test. A thin slab or disk is sawed from both ends of the billet from which the final bar or forging is to be made. These disks are heated in muriatic acid which eats into any slag, dirt or discontinuity and enlarges it so that it is easily visible to the naked eye.

If both ends of a billet are clean, experience shows that the metal in between will be clean also. The photographs (Fig. 1) show how disks cut from two different mold steel billets responded to the hot acid etch test.

B. *Strength*: This refers to the amount of pressure the finished cavity will withstand without upsetting, bending or breaking. This becomes a vital matter in dies having very thin sections or in larger dies where the entire surface might cave in under heat and pressure. This property is measured primarily by the "elastic limit" of the steel—the higher the "elastic limit," the greater the strength of the mold steel. Obviously, alloy mold steels can be heat treated to show more strength than plain low carbon mold steels, and this is a reason why alloys are put into the better grades of mold steel.

C. *Wear resistance*: It is well known that hardened tool steel wears many times longer than soft machinery steel. Also that case hardening or cyaniding a low carbon steel will increase its surface hardness and wear resistance. It is also well known that certain alloys can be added to a steel to (Continued on page 158)

1. This illustration shows how two different mold steel billets responded to the hot acid etch test. The difference between the "clean" and "dirty" billet is easily seen



# CRUCIBLE STEELS FOR PLASTIC MOLDING

MADE BY *Craftsmen* FOR *Craftsmen*

A Crucible craftsman "cogging" a hot billet of Hoballoy for a multiple cavity mold... In Crucible employ 19 years... His father formerly had charge of the 2-ton hammer which he runs today.



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Cavity Dies to be carburized.*

*Crusca No. 12-B or Crusca  
Plastic Cut Die Steel for  
Machined or Cut Dies to be  
carburized.*

*Ketos Oil Hardening or  
Champion Non-Changeable  
for Machined or Cut Dies  
to be oil hardened.*

*Ketos, Champion Non-  
Changeable or La Belle 2-11  
for Master Hobs.*

Send for Folder, "The Right  
Steels for Plastic Molding."

The prominence of plastics has come about in recent years yet a long-established molder has been using one brand of Crucible Tool Steel for more than a quarter-century. Our craftsmen, metallurgists and service men share in, and pass on to steel users the benefit of this long specialized experience. We are headquarters for the highest grades of steels, applicable to the various types of plastic molding tools as indicated in the listing above. Send for folder, "The Right Steels for Plastic Molding."

**CRUCIBLE STEEL COMPANY OF AMERICA**  
GENERAL OFFICES: CHRYSLER BUILDING, NEW YORK CITY

# BERYLLIUM COPPER ALLOYS

by LOUIS L. STOTT and J. EARL SIMONDS

IN THE FALL OF 1935 THE AVAILABILITY OF CAST plastic molds made from Beryllium Copper, a heat treatable copper alloy, was announced by the Gorham Company. For over two years prior to this announcement this company in cooperation with the Beryllium Corporation, producer of beryllium alloys and the owner of patents covering this application, had been conducting research and development to ascertain the practicability of beryllium copper molds and to work out a new technique of mold making for use in the plastic industry. In the two years which have followed this announcement many things have been learned concerning this new material for molds. Early optimism has been tempered by the realization of certain limitations, and some early objections are being disproved as knowledge of methods of casting increases.

Those familiar with the stringent requirements of plastic molding and with the problems involved in casting to close dimensions have not been discouraged with unsatisfactory results in certain tests, realizing that trial and error is the only road to progress in pioneering work of this character. A conservative policy has been followed in the promotion of beryllium copper molds, and no claim can be made for a large number of these molds being yet in use. Nevertheless, the past two years of experience with these cast molds has been one of achievement. Many molders who at first were skeptical have given beryllium copper a definite place in their manufacturing technique and now look for opportunities to make use of it.

New developments in any field usually have had many hurdles to overcome before being accepted. Only a few years ago there was considerable opposition to the introduction of light-colored translucent urea molding materials. "We'll never be able to keep it clean in our plants," "Price is too high," etc., were once common phrases; yet, these materials opened up new markets and today are an important factor with almost every molder.

The newly developed injection method of molding thermoplastic materials has met and still is meeting with considerable opposition, but there have been over two hundred and fifty injection molding machines sold in the United States within the short space of two years, and tonnage of consumed thermoplastic molding materials is increasing at a remarkable rate.

Taking all the evidence to date covering experience with beryllium copper cast molds, considering the failures along with the successful applications, the only fair conclusion is that this new method of mold-making is destined to be a very useful innovation which will open up new and uncharted fields to the plastic industry

hitherto closed because of the high cost or machining difficulties of steel molds.

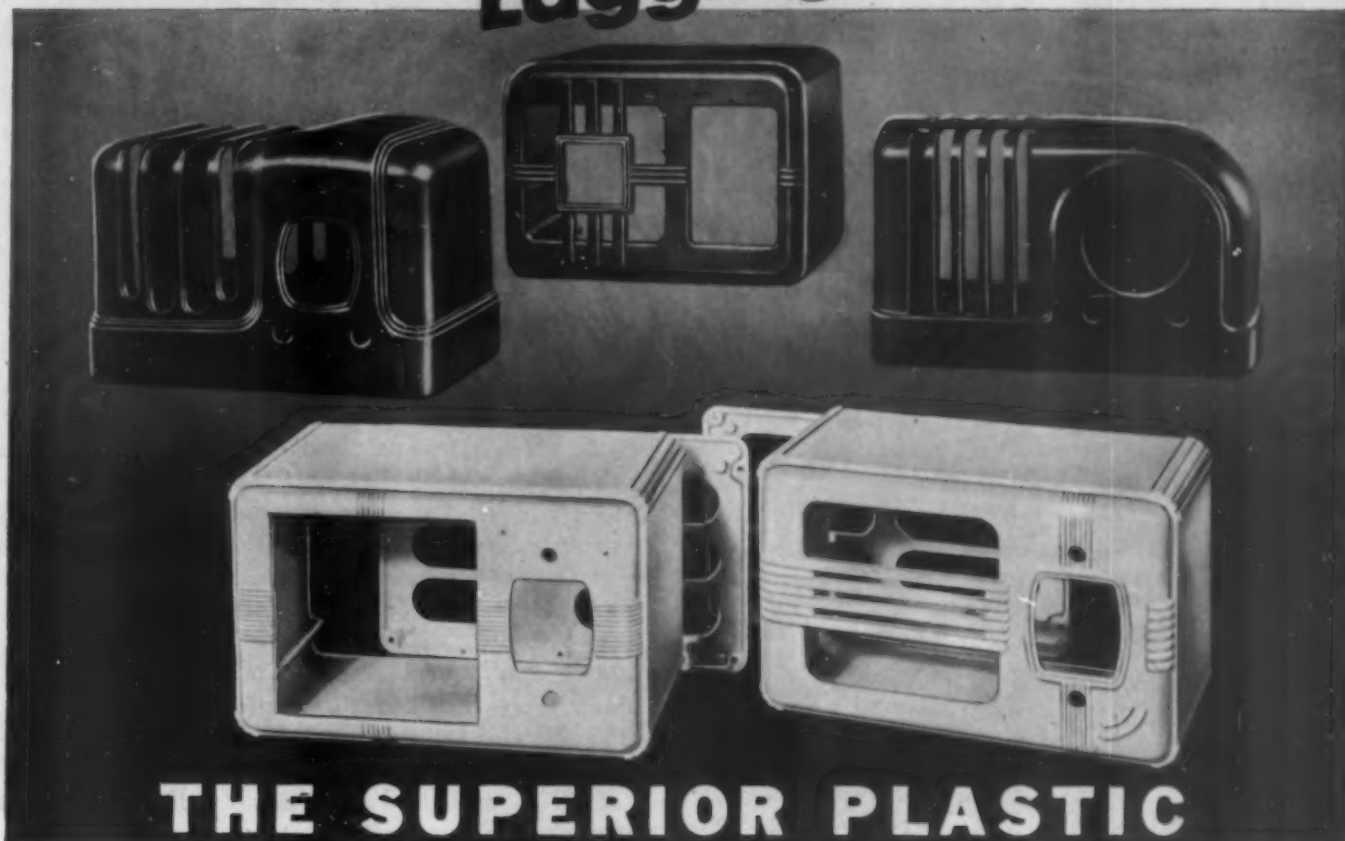
In some cases it is possible that the limitations of beryllium copper molds have impressed the average molder more than their extensive possibilities. Certainly, no claim can be made that these molds are a cure-all, or that they can be economically used in place of steel at all times. Furthermore, it must be realized that in some instances molds of this type cannot be handled as roughly as steel without damage and therefore require careful operators. Keeping all this in mind, the indications to date are that cast beryllium copper molds are fundamentally practical, economical, and durable where one or more of the following factors are present:

- (1) Where tolerances are not too close.
- (2) Where odd and unusual contours are involved.
- (3) Where only short runs or samples are desired.
- (4) Where only a few cavities are required.
- (5) Where maximum economy for experimental purposes is essential.
- (6) Where rapid heat conductivity and low specific heat are important.
- (7) Where a high degree of ornament or decoration is wanted.
- (8) Where pieces of great area would be difficult or impossible to machine or hob in steel.

To appreciate the advantages of cast beryllium copper molds it is necessary to mention briefly the metallurgical background of this alloy. As is well known, copper is a relatively soft metal, being hardenable in general commercial practice only by cold working, and then only to a moderate degree. In 1926 German investigators at the firm of Siemens & Halske found that small additions of the element beryllium, at that time a metal almost unknown outside the laboratory, made copper temperable by heat treatment to remarkably high physical properties for a non-ferrous alloy. It was discovered that chisels made of beryllium copper could readily cut a slice off steel boiler plate; springs of this new alloy would far outlast steel springs under conditions of corrosion and fatigue. A truly temperable copper alloy had at last been found.

Even before this discovery those who had worked on beryllium knew that it was one of the most unique of the metallic elements. On paper its properties are such that romantic speculation has run riot with its possibilities as a light metal. About two thirds the weight of aluminum, beryllium appears to be considerably stiffer than steel. First iden- (Continued on page 162)

# Here's **FIRST AID** to Lagging Sales . . .



**THE SUPERIOR PLASTIC**

# INSUROK

**T**HE modern buyer is intolerant of commonplace "utility". He is satisfied with nothing short of superb performance . . . clothed with beauty in design. To win profitable acceptance for their products in today's competitive markets manufacturers turn to INSUROK, the superior plastic.

This amazing plastic offers designer and artist a medium that knows few practical limitations . . . that gives permanence to the skill of master craftsmen . . . that vastly improves, structurally and in appearance, every product of which it becomes a part. Investigate the use of INSUROK for present or contemplated products. You'll find it profitably advantageous to do so. Consult the Richardson Design, Engineering and Research Laboratories without obligation.

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Lockland, (Cincinnati) Ohio  
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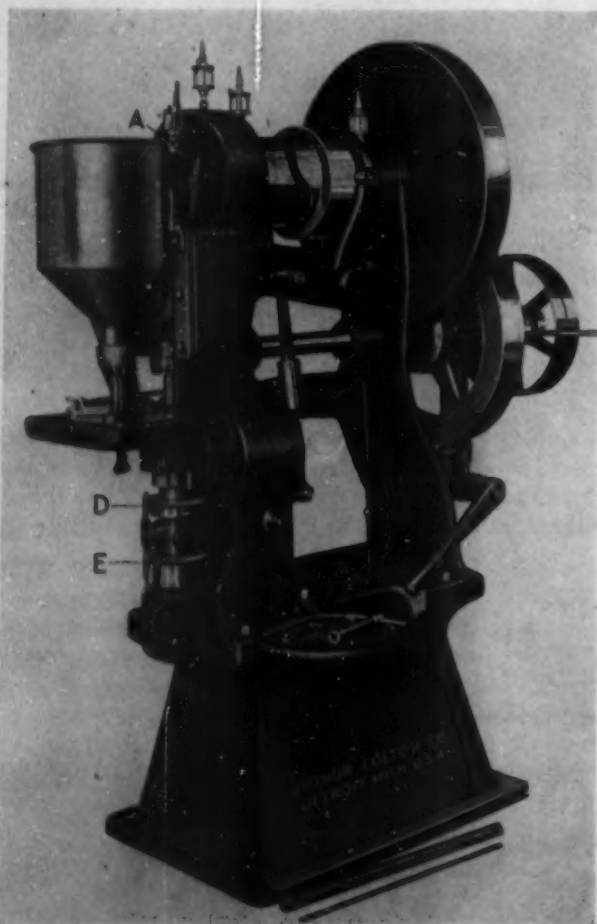
# PREPARATION OF RAW MATERIAL FOR MOLDING

by FRED K. DAVIDSON

THE RAW MATERIAL FOR THE PLASTIC MOLDER comes from the supplier or primary manufacturer in many forms, usually packed in moisture proof drums ranging in weight from 200 lbs. to 400 lbs. each. The major portion, woodflour phenolic, ureas and some cellulose acetate, is of the consistency of granulated sugar. Canvas base phenolics and compounds in the higher impact classes are by their very nature fluffy. Asbestos compounds of the short fiber type are granular but the longer fiber materials are more like the impact types. Cellulose acetate may be granules or it may be sheets or small cut up pieces of sheets.

For any molding operation these materials must be broken down into definite weights, firstly because economy requires that only a definite amount be allocated to the construction of a given part, secondly because the slightest deficiency in a quantity fed to a mold will cause

Preforming machines press molding powder into preforms or "pills" much the same as aspirin tablets or other pills are made except larger, of course. This is a single punch preforming press. (Photo courtesy Arthur Colton Co.)



a reject and finally because the speed of the molding operation requires that everything be prepared in advance to avoid undue delays in the operation of and production from expensive presses and dies.

This preparation of the material may be the weighing of the required amount by hand on sensitive scales which read in grams and fractions of grams or the same operation preformed automatically by machine. The hand-weighted material is stored in small containers, such as paper drinking cups, or, in larger weights, in mailing tubes. These are served to the press operator as he needs them. Usually this preparation is done in a separate weighing department but sometimes the timing of a cure is such that the press operator may be able to do his own weighing. In that case a drum of the material is placed beside his unit, scales are provided and he serves himself.

Small weights, seldom over one ounce, can be measured with a cup of predetermined volume. This is sometimes developed into a special loading board having a group of such cups arranged to match the pattern of the mold cavities and so constructed that after filling and insertion in the open mold, the bottoms of the containers can be opened simultaneously and all cavities filled at once. Volume feeding is confined to the press operator. The objection is the necessary factor of safety in providing excess material and its resultant waste.

Such a preparatory method is excellent and worth while in handling very light pastel ureas where every exposure of the material increases the danger of contamination by foreign matter which means a positive rejection. The drum can be kept sealed at the press and the exposure of the material is limited in time and distance, and is therefore controllable.

The largest percentage of a molder's material, however, is pelleted or pilled on specially constructed machines. The object of pilling is twofold, for convenience in handling and for accuracy of weight. Many flash molds of today are so shallow that they will not hold the necessary volume of loose powder which has a bulk two and a half times the final molded volume. A pill is roughly one and one eighth times the final volume.

Pills are also used to get a concentration of material in one portion of the mold, to slip under an insert or side pin in order to avoid the heavy flow of the loose material which would be all on one side and would create dangerous strains when forced past the pin or insert under the usual molding pressures which approach three thousand pounds per square inch.

Special shapes are developed in pills, better called preforms—in that case. A tube may be molded horizontally with a preform placed above (Continued on page 168)



**WE MOLDED THIS CARBURETOR  
IN 1915**

## **EVEN WAY BACK THEN SHAW HAD A LONG RECORD OF PIONEERING**

It took pioneering spirit to be a molder back before the turn of the century when Shaw started in business. But the important fact for you is that here at Irvington, we have retained that pioneering spirit.

Our engineers, pioneer developers of many of the standard processes of today, can place their background, their experience, their knowledge and their thirst for the better-way-to-do-things at your command.

Our modern plant is completely equipped for the most economical production of transfer, injection or compression molded parts of every type of compound . . . often by processes or methods operating under exclusive Shaw patents.

That plant, these engineers . . . and the pioneering attitude that has made them successful . . . are at your command for consultation or service.



1892

# **SHAW INSULATOR CO.**

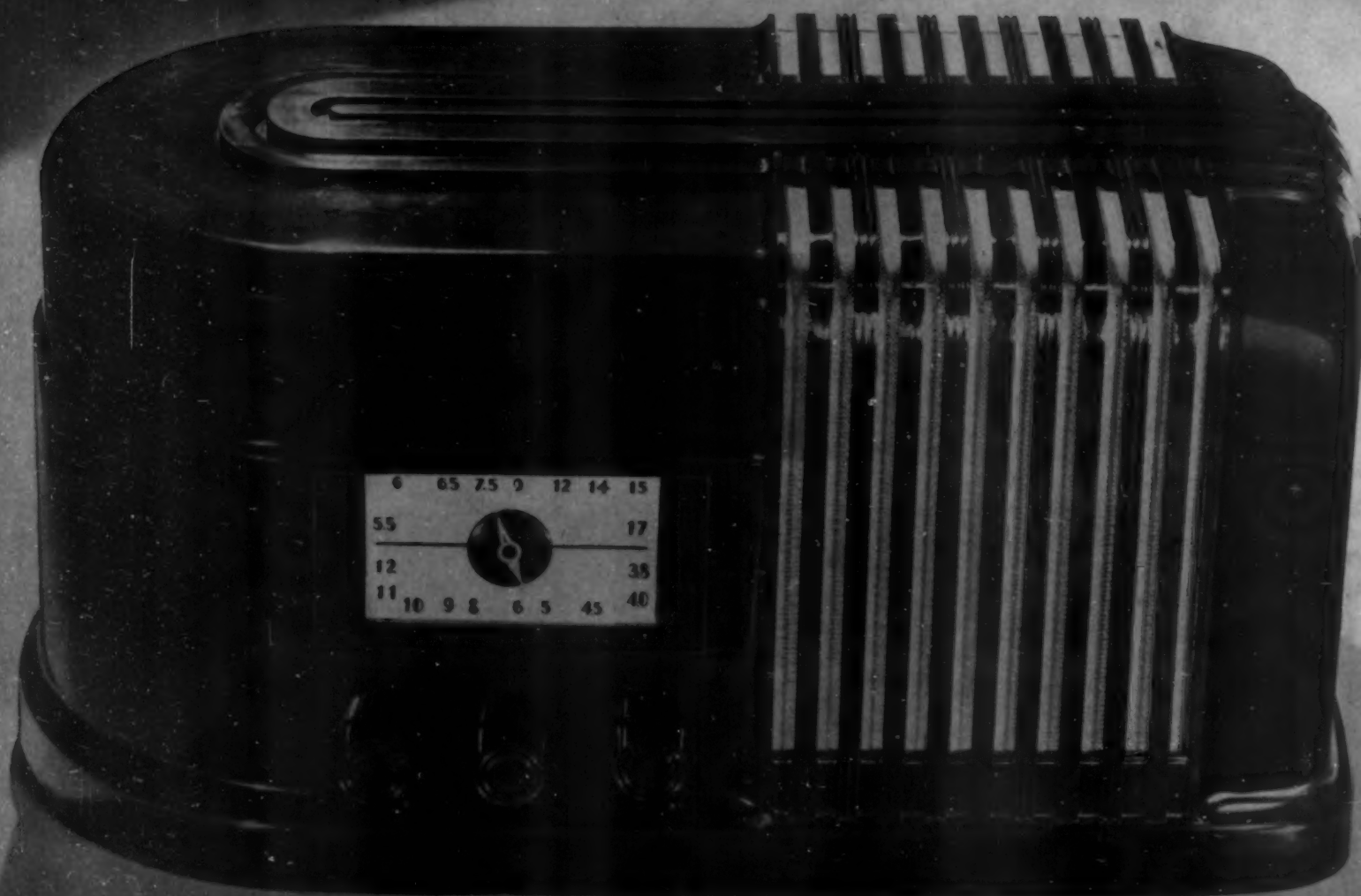
**IRVINGTON, N. J.**

OCTOBER 1937

133

# Why

## COLONIAL RADIO CHOOSES AM



### Molders of:

BAKELITE  
PELASTACELE

DUREZ  
THIOKOL

PLASKON  
FIBESTOS  
COLD MOLDED COMPOSITION

BEETLE  
TENITE

LUCITE  
LUMARITH

### Offices in:

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LOS ANGELES

PHILADELPHIA  
ST. PAUL

CLEVELAND  
CHATTANOOGA

# AMERICAN INSULATOR CORPORATION

to mold the Sears Roebuck Radio Cabinet!

**BECAUSE** Beauty, sturdiness, ease of assembly, everlasting finish...all these qualities are attainable—at reasonable cost—only with plastic molding.

But when you plan a molded radio cabinet...or any other molded part...you place yourself in the hands of a second party, your plastic molder. His technical skill, his experience, his ingenuity, his equipment...these things measure, in advance, the success or failure you will achieve.

It is for this reason that so many of the largest users of molded products turn to the American Insulator Corporation, year after year.

More than a generation of experience; a plant second to none in plan and equipment, a staff with a long record of outstanding successes, many centrally located service offices and a reputation worth our every effort to maintain...these things are your guarantee of a type of design and production typified by this outstanding cabinet

We invite your inquiries...pledge you our fullest cooperation.

## SEND FOR THIS BOOK

*The American Insulator Corporation is one of the largest molders of stock parts...handles, knobs, boxes, etc. Send for this catalog of stock molds, the most complete ever compiled. No obligation. No charge.*



**AMERICAN INSULATOR CORPORATION**  
**NEW FREEDOM, PA.**

# COMPRESSION MOLDING

by L. W. ANDERSON

COMPRESSION MOLDING IS AN ART BY NO means new. It was known and used several thousand years ago by the Chinese in forming articles of papier mâché, and during the middle ages in molding various natural resins. The modern art of compression molding had its foundation in the invention of the hydraulic press in 1653, though commercial use of hydraulic presses for molding did not come until Goodyear discovered the process of vulcanizing rubber in 1839.

However, it is only within recent years, with the development of our modern synthetic resins, that compression molding has come into its own as an instrument of economical, high-speed, quantity production. Today, it is being used for the production of literally thousands of different articles, ranging all the way from tiny electrical parts, to housings for machines of considerable size. And so rapid is the progress being made in the development of both molding materials, and the art of molding itself, that it is clearly evident the possibilities have scarcely been touched.

There are of course many articles for which the physical properties of the plastic materials are so well suited, that molding is by far the most satisfactory method of production, even though quantity requirements are comparatively small. Yet compression molding requires first of all, an extremely accurate, highly finished mold of hardened steel, which entails a substantial initial outlay. When only a limited number of pieces are to be produced, therefore, the price of the mold may constitute a formidable cost factor. On the other hand, when the mold cost is spread over a large number of pieces, it becomes a comparatively small item. This fact, combined with the rapid production, and accurate, uniform product which characterize the process, makes compression molding in many instances the ideal method of attaining quantity production at the lowest possible cost.

In addition to the economies which are bound to result when parts are produced rapidly from low-priced materials, the compression molding process affords incidental savings which are equally impressive. One of the most important of these arises from the fact that many pieces can be molded virtually complete, thus entirely eliminating assembly costs. A typical example is the Silvertone Radio cabinet illustrated in Fig. 1 (page 174). With the exception of the knobs, the cabinet was molded in one piece. The saving thus effected was an important contributing factor to the low price which made this set a sensational sales success.

Another great advantage resulting from the molding process is the reduction of the number of machining operations required. In dealing with ordinary materials

such as wood or metal castings, a certain amount of machining is nearly always necessary to ensure proper form and accuracy of dimensions. Such operations are done away with in the molding process, since each piece is uniformly accurate when it comes from the mold.

Again, with other conventional materials, considerable handling is necessary in connection with drilling and tapping for assembly. When compression molding is used, threads can frequently be molded in or holes ready for tapping. Where additional strength is required, metal inserts are employed. These are usually screw machine parts, produced at extremely low cost, and are inserted in the mold just before it is charged with the plastic material. In the course of the molding process each insert becomes an integral part of the completed piece, requiring no further attention.

One of the most interesting savings to be effected through the use of compression molding is that which occurs in finishing. A molded piece may be polished if extra luster is desired, but beyond this no finishing whatever is required. Plastic molding materials are now obtainable in such a wide range of colors that it is possible to mold the piece in practically any shade desired. The resulting finish is not only beautifully rich, but far more lasting and durable than any applied finish known.

In view of such marked advantages, the manufacturer may ask, "How can we determine whether compression molding is suitable for our purposes? And how can we best utilize its economies and other advantages?"

In order to answer these questions intelligibly, it is necessary first to explain the fundamentals of the molding process. Briefly, a predetermined quantity of the plastic material, either in the form of loose powder or a compressed tablet, is placed within a hardened steel mold, accurately machined to the exact form and dimensions desired. Due to the shrinkage of the material in the molding process however, allowance must be made in the dimensions of the mold to take care of this. This shrinkage varies not only with each type but also each class of material. For example, the standard woodflour phenolic materials have a shrinkage of about .008 in. per lineal inch; the asbestos filled and macerated canvas phenolics a shrinkage of about .005 in. per lineal inch; the ureas about .009 in. per lineal inch and the acetates about .0025 in. per lineal inch. The mold is then subjected to heat and pressure. After a few minutes, the pressure is removed, and the piece emerges, hardened and formed into the desired shape.

In general, there are two types of hydraulic molding presses: the hand press, in which the mold derives its heat from platens; and the (Continued on page 172)



## THE DISPLAY SUCCESS OF THE YEAR is a NORTON development

**Norton Merchandising Ingenuity and Designing Skill Are  
At Your Command When You Plan for Moldings  
That Sell on Sight**

An ingenious idea stands back of this Ingersoll Display . . . the time-proven idea that if you give a dealer a convenience apart from your product, he will display your product—and push it—in return. Hence, this change maker . . . which has earned preferred position for Ingersoll on thousands of busy counters. But ingenuity didn't end here. Norton designers introduced the theft-proof glass plate, impossible to lift out until, presto! . . . the dealer presses a little inexpensive lever at the back and the plate rises out of its grooves, and permits removal or examination of the watches beneath. Norton designers developed the wrist-band holders, too, ingeniously molded to display each watch to the best advantage.

For your product . . . package . . . or display . . . Norton experience, in merchandise, design and molding, can be of equally great and profitable assistance. Backed by a modern, efficient plant, Norton engineers can afford you an unusual type of service . . . the type that has attracted to us the cream of industrial molding accounts. We invite your inquiries.

**NORTON LABORATORIES, INC.**  
LOCKPORT NEW YORK

# INJECTION MOLDING

by BYRON J. MINNIUM

THE PROCESS OF MOLDING THERMOPLASTIC materials is quite similar to the older process of die casting metals. In fact, many of the developments in injection molding have closely followed, in principle, if not in time, those in the latter field. Die casting was originally developed to produce printers type at low cost. Later it covered the casting of much larger pieces, and the use of higher melting-point alloys.

Similarly, injection molding was first applied in producing very small items in large quantities, and was confined to one or two materials of rather limited properties. Today we are able to produce fair sized castings and the list of molding materials applicable to the injection process is constantly growing.

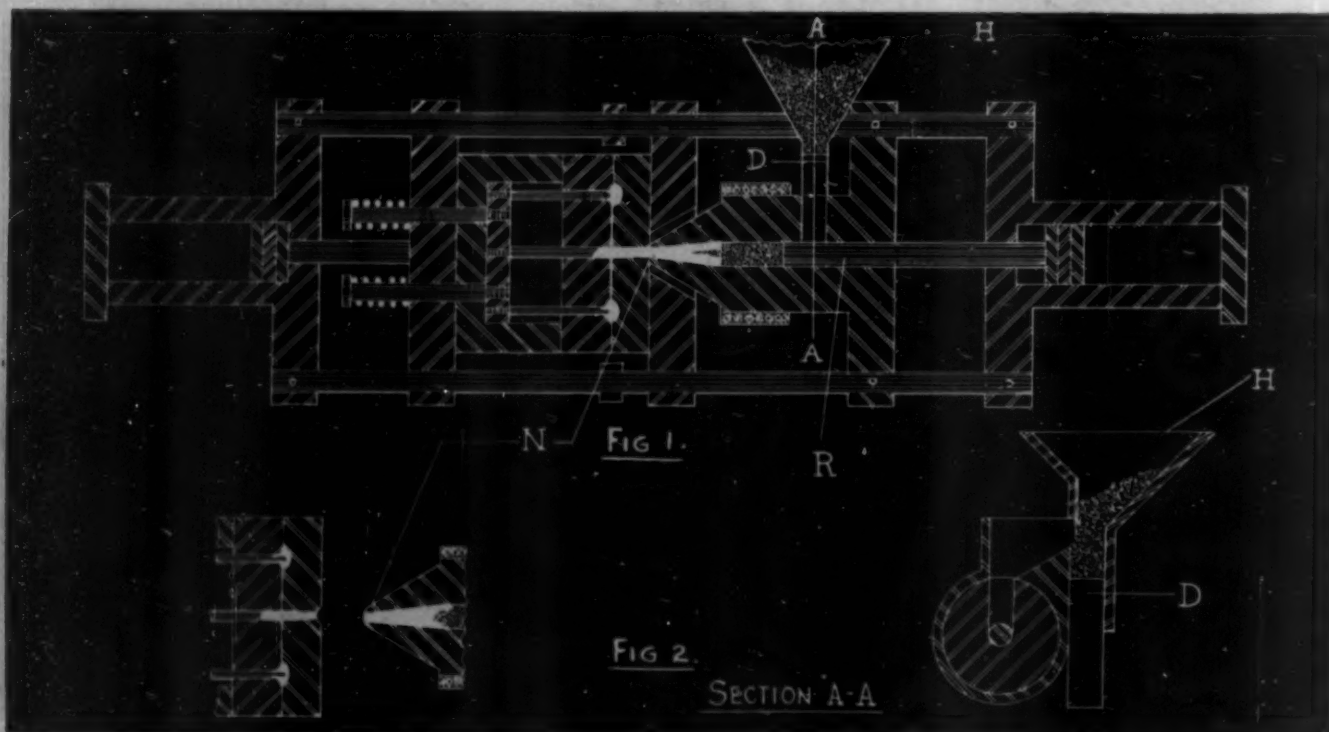
The basic difference between pressure molding and injection molding is that, while in the former, molding powder in granular, or tableted form, is placed in hot cavities and pressure is then applied; in the latter, the plastic material is gradually heated to the proper temperature as it progresses through a heating cylinder and is squirted, or injected, through a small orifice, or nozzle, into the inter-connected cavities of a relatively cold die, where it chills and from which the casting is ejected. The heating is usually done either by electric heaters or transferred by oil which is heated electrically.

Fig. 1 is a simple, cross-sectional view of an injection molding machine in which *H* is a hopper into

which granulated molding material is dumped from time to time. A dosing device *D* controls the amount of material carried from the bottom of the hopper into the space ahead of the injection ram, or piston *R*. *D* is usually automatic in its action so that, if it feeds too large a dose for any one injection, it reduces the amount fed for the next injection, so that the average rate of feed over a period of time is equal to the amount injected into the die cavities in the same length of time.

While the space ahead of the piston is being filled from the hopper, the back, or movable half of the split die, is brought against the front half of the die by suitable die-closing means, and the entire die moves through a small distance until the end of the injection nozzle *N* is pressed into the sprue opening in the front half of the die. In this case, the die-closing mechanism is shown as an hydraulic piston, but it may consist of a toggle-joint mechanism, or any other suitable device. The so-called "stationary" part of the die is held away from the injection nozzle except during the actual injection time, so as to prevent undue heating of the die and chilling of the material in the end of the nozzle. Furthermore, this action provides a parting point between the tapered sprue (which is integral with the casting) and the fluid material in the heating cylinder. The position of the die relative to the nozzle is shown by Fig. 2.

As soon as the die is (Continued on page 178)



The background of the advertisement is filled with numerous examples of plastic molded products. These include several different styles of clocks (some round, some rectangular), a car's front grille, a camera body, a mechanical device resembling a pump or motor, a funnel, a spoon, a small bellows, and many other miscellaneous parts like knobs, lenses, and housings. The items are arranged in a collage-like fashion around the central text box.

# HEADQUARTERS

To literally hundreds of leading manufacturers, large and small, Chicago Molded is today recognized headquarters for plastic molding.

This recognition has not come suddenly, as the result of mere size or intensive sales effort. Rather, it is the development of long experience—experience in which these firms have learned that Chicago Molded's engineering skill, production facilities, and intelligent cooperation can always be depended upon to do the job right.

The new catalog, "The Story of Plastic Molding," is being acclaimed as one of the most valuable handbooks ever published for the user of molded parts. A copy is yours for the asking, if you'll write on your letterhead.

**CHICAGO MOLDED PRODUCTS CORP.**  
2146 Walnut St. Chicago, Ill.

The background of the advertisement is filled with numerous examples of plastic molded products. In the top left, there's a large rectangular clock with a circular face. To its right is another rectangular device with vertical ridges and a smaller circular gauge. Further right are several small, dark, curved components. On the far right, a tall, slender mechanical part stands vertically. Below these, there are more circular gauges and some ring-like structures. In the center-right, a larger clock with a square face is visible. To its right is a small, round, dome-shaped object. Below the central text box, there's a large, complex mechanical assembly with multiple components. To its left is a circular clock face with numbers. Further left is a rectangular device with horizontal ridges. At the bottom left, there's a camera-like device with a lens and various controls. To its right is a long, cylindrical component with a handle. At the bottom right, there's a funnel and a spoon. The overall arrangement showcases the versatility of plastic molding in creating diverse shapes and functions.

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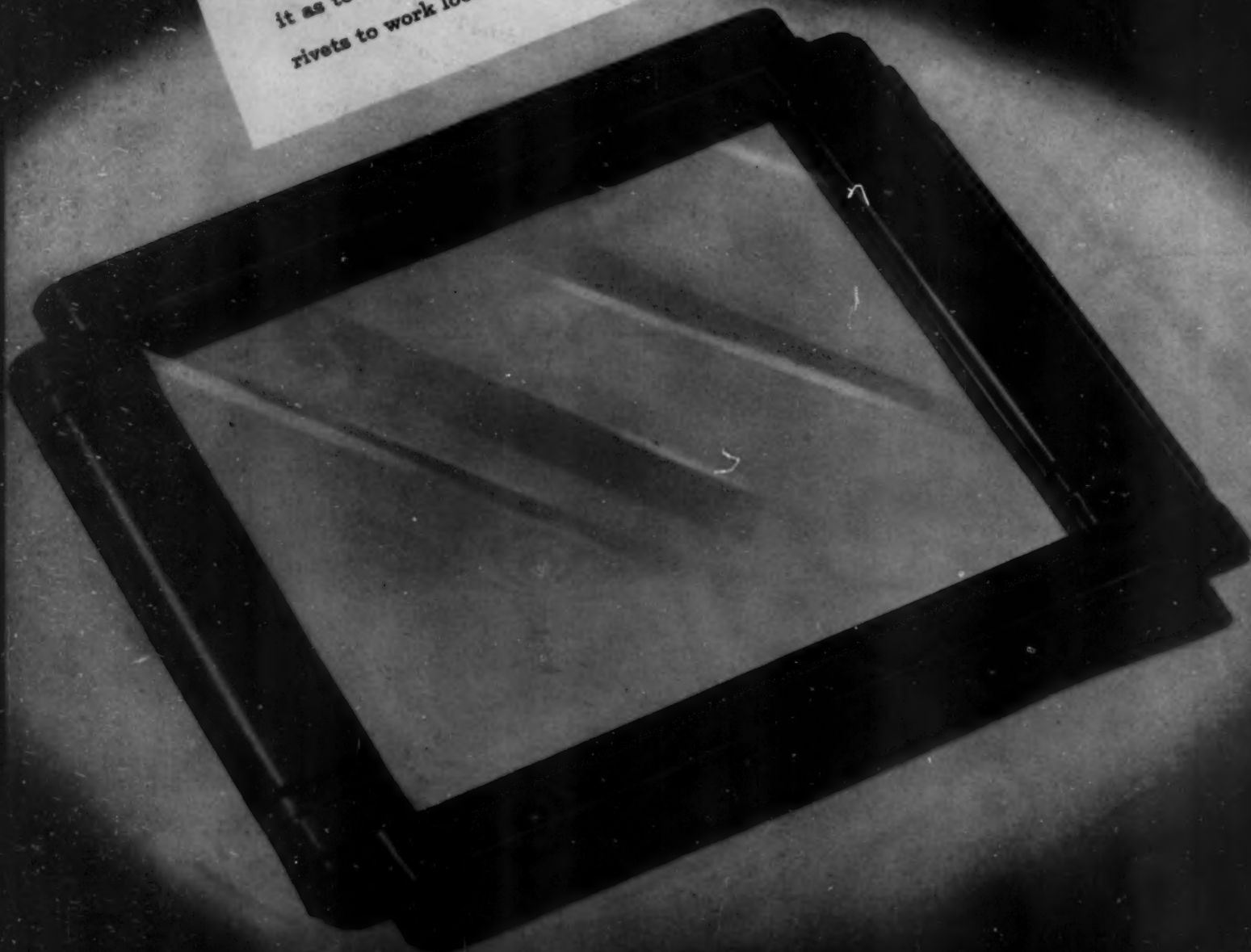
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**CHICAGO MOLDED PRODUCTS CORP.**  
2146 Walnut St. Chicago, Ill.

# TALKING OF EXTRUSION MOLDING...

Here are two Mack Molding jobs that set new standards for size and quantity

Measuring six and one half inches, overall, this RCA Radio Bezel is one of the largest injection molded pieces ever made. But more, note that it completely eliminates all assembly operations . . . since the glass is an integral part of the unit, with the frame so molded around it as to form a permanent union. Nothing to rattle . . . no crews nor rivets to work loose.





## TALKING OF DESIGN . . .

Here is a Mack Molded Box Which Has Won  
Thousands of New Users for Gem Razors

Not a spectacular nor an unusually difficult molding job is this attractive and sturdy Gem Razor box. But where design counts the most, Mack Molding Company's experienced designers and engineers have built real sales appeal into the package. After all, Mack Molding Company was the first to enter package molding in a serious way. Mack Molding Company has done more packages—and more successful packages than any other firm. For a package or a housing, you can choose no better aid than the Mack organization.

Here at the Mack Molding plant, we are not content to let technique ride along at present levels. We welcome the new job as a challenge to our ability to lick it. And, as many leading users of molding have discovered, we can lick it . . . time after time . . . usually at a saving of both time and money. We invite your inquiries. Address

# MACK MOLDING CO.

MAIN STREET

WAYNE, N. J.

# COLD MOLDING

by N. S. STODDARD

THERE IS A DEFINITE AND IMPORTANT POSITION for cold molded materials in the plastics industry. It is true that hot mold has replaced cold molded for many applications, however, cold mold maintains its leadership in applications where resistance to high heat and arcing is necessary. This consequently narrows, more or less, the use of cold mold to the Electrical Industry which finds cold molded parts highly indispensable in successfully designing and manufacturing its products to assure adequate insulation and dependable operation.

## Methods of manufacture

Briefly, cold molded plastics differ from hot mold in that the molding compounds are molded to form at room temperature and cured in electrically heated ovens after removal from the molds. The length of cure depends on the size and shape of the part but generally speaking the curing time varies from 24 hours to 72 hours with temperatures ranging from approximately 125 deg. F. to 425 deg. F. The parts when removed from the ovens are hard and possess considerable strength. The cold molding operation is much faster than hot molding since the curing is not done in the mold.

For example, a single cavity mold for a cold molded heater-connector casing will produce 400 to 500 pieces per hour whereas the same single cavity mold, designed for hot molding will produce 20 to 30 pieces per hour.

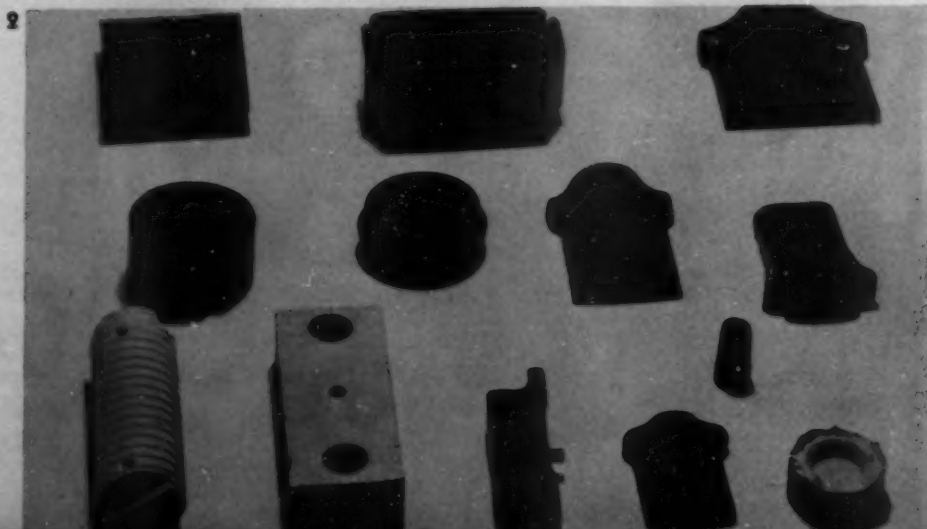
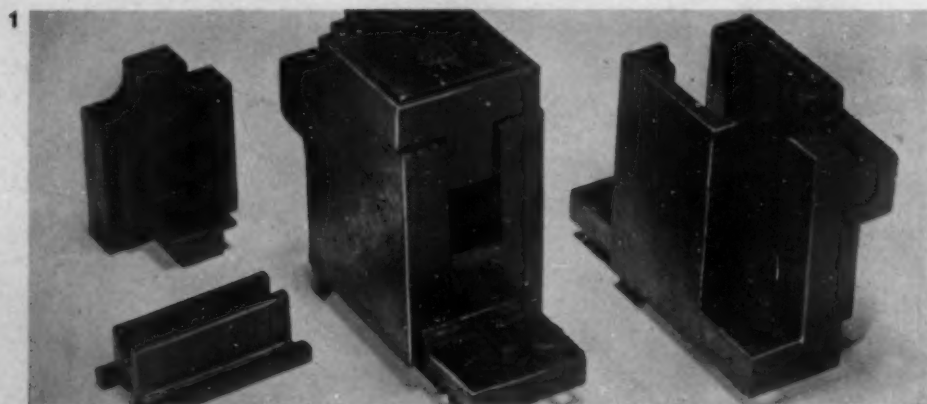
It is obvious therefore that in order to step up hot molding production to equal that of cold molding, multiple cavities are required—this means a considerable increase in mold costs and a distinct advantage for the cold molding method which requires less investment for its molds.

## Types of materials

There are two types of cold molding compounds which predominate, refractory materials and non-refractory. The former contains such ingredients as cement, asbestos and other inorganic materials, which, when blended together and cured properly, offer a white, hard composition, which will withstand very high temperatures up to approximately 1000 deg. C. and does not break down as an insulator when exposed to the electric arc. The latter or non-refractory materials are made with asbestos, asphalt and special drying oils and are black in color. They offer resistance to both heat and arcing in the lower ranges.

## Tolerances and finishes

In cold mold materials the shrinkage is two to three times that of hot molded plastics. Because of this, greater tolerances are required for cold mold. There are no set plus or minus tolerances for cold molded due to the fact that the tolerances de- (Continued on page 184)



1. Three molded parts and how they appear assembled. 2. Miscellaneous parts of both refractory and non-refractory type of cold mold unfinished, just as they come from the mold. (Photos courtesy General Electric Co.)

# Waterbury Plastics



A really complete plastics service has always been Waterbury Plastic's outstanding feature. In addition to our 81 years of molding experience, which incidentally makes us the oldest active molders, we have recently completed our new plastics plant. Here in this new plant we have the most modern, efficient production layout. We have purchased enough new equipment to insure our ability to handle an increase of 100% production volume. Even at this early date records indicate that our volume capacity will soon have to be increased once again. We have Engineers, Designers, a Tool Shop wherein we build all our own molds, a Metal Division for supplying all necessary inserts and metal parts used in conjunction with molded pieces. In view of the great preference manufacturers are showing toward Waterbury Plastics, why not call in a Waterbury Engineer the next time you have any requirements? He can show you the



way to better plastics at a saving. You also have the choice of all the commercial molding compounds such as—Bakelite, Beetle, Durez, Plaskon, Tenite, Resinox, Lucite, Catalin and Shellac Composition.



**THE WATERBURY BUTTON COMPANY**  
**PLASTIC DIVISION**  
 EST. 1812  
**WATERBURY, CONN.**  
 NEW YORK CITY • BOSTON • PHILADELPHIA • ROCHESTER  
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Two views in the plant of Chicago Molded Products Corp. showing care used in preforming light color powders (left) and a shrouded molding press (right)

## CARE NECESSARY IN COLOR MOLDING

by WHITING N. SHEPARD

WITH THE INTRODUCTION A FEW YEARS AGO of light colored urea-formaldehyde molding compounds, a new problem confronted the molders in this country, who were set up to fabricate only the opaque, dark colored phenolic type compounds. And as the production of pieces in translucent, pastel urea colors has increased, so has this problem of producing the pieces free from dirt and contamination become increasingly more difficult of solution.

Urea compounds are manufactured chiefly in colorless, white, and pastel shades, and a single speck of dirt in the molded piece causes an expensive rejection; further the material is extensively used because of its translucency, particularly in illuminating applications, and the presence of any contamination whatsoever in an illuminated piece renders it commercially useless.

The difficulties attendant on the fabrication of these materials become apparent, if we follow the operations through which a drum of white urea compound must pass before it emerges from the multi-cavity dies in the form of finished articles. The material is usually first preformed in briquettes in unheated dies. These briquettes are then taken to the press in which the die is set, and the finished article then molded. This operation sounds absurdly simple, but remember that during the preforming operation no particles of other colors, no

grease, and no dirt must contaminate the material. And while the briquettes are being loaded into the dies, neither dust particles, nor floating specks of foreign materials, nor dirt of any kind may settle in the dies. Then too, consider the heavy machinery necessary in molding which is difficult to keep spotless; consider the necessity of having presses close together to conserve space (and in each press a different material may be running), and the difficulties inherent in producing immaculately spotless moldings become apparent.

Great care is taken in the handling of the light colored materials, care which begins in the preforming room. Whenever possible a room or rooms, housing preforming equipment, are set aside exclusively for urea materials. Walls and ceilings are whitewashed, and frequently a suction system is installed to remove particles of powder suspended in the air. Careful attention is given to the preform press itself, keeping it free of objectionable grease spots and dirt areas always to be found in connection with machinery in motion. If possible the operators are dressed in white, and if they are attending machines preforming both phenolic and urea materials, must be careful not to transfer by way of arms, hands and clothes, the dark colored materials into the lighter ones.

So much for the preforming operation. The briquettes are placed in carefully (Continued on page 186)



## *Every Type of Plastic Molding*

**T**HERE is no product made of plastic material that is not within our manufacturing resources. We mold all varieties of parts or complete products in

**BAKELITE    PLASKON    DUREZ  
TENITE    BEETLE    LUCITE**

A few examples are illustrated above, widely different in character and some very complex, molded from customers' specifications. A similar breadth of range runs through all our custom molding.

Complete mold service in all colors from your blueprints or specifications. We also offer a wide choice of standard parts such as handles, pulls, etc., from stock molds. Delivery can be made on short notice.

*Illustrated stock parts catalog  
will be mailed on request*

**IMPERIAL MOLDED  
PRODUCTS CORP.**

2927 W. Harrison St., CHICAGO



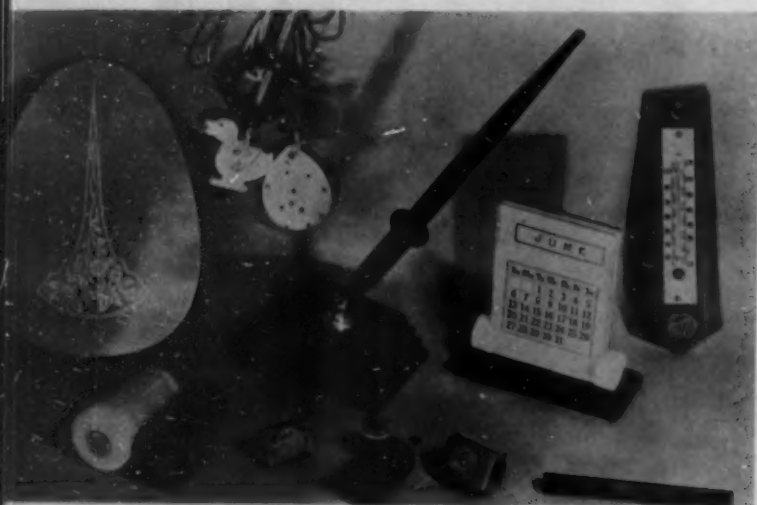
### *Sani-Trete Tableware*

An inviting, thoroughly modern character is given to any dining room by the distinctive appearance of these brilliantly colored pieces. Quickly washed, rustproof, wearproof. Full details and illustrated pamphlet sent on request.



Examples of printing on plastics where as many as four colors may be used by the Anigraphic Process

## PRINTING, STAMPING AND ENGRAVING PLASTIC PRODUCTS



Almost any plastic product may be stamped with roll leaf for identification or decoration. Gold, silver or any metallic color can be obtained. (Top photo, courtesy Peerless Roll Leaf Co., Inc. Lower photo, courtesy Griffin, Campbell, Hayes, Walsh, Inc.)

SEVERAL METHODS OF PRINTING ON PLASTIC materials have been developed recently and manufacturers who want to brand their products with a trade name, advertising message or even decorative effects will discover that the job can be done simply and effectively.

### Roll leaf stamping

Roll leaf stamping is a popular method of imprinting in current use. Any material the surface of which can be impressed with heat and pressure is eligible for this type of printing; wood covered with lacquer, acetate, pyroxylin or any of the resinous plastic materials. For years chemists had labored to produce a stamping material that would have the proper anchorage, and finally this process was discovered which enables the stamping to become an integral part of the plastic material itself—it so fuses into the material that it cannot be rubbed or scratched off. Heat and pressure are required to successfully imprint on plastic materials.

There are many and varied types of machines used for stamping on plastics. Presses which are operated by hand or by foot, automatically, for multi-purpose and quantity work; presses of all sizes, for all kinds of jobs, are available to the manufacturer's requirements.

Although specifications are varied, the theory of operation is the same. Roll leaf, which is composed of either metallic or pigment colors is mounted on paper tape providing a means of carrying colors through the machine. It is placed on a bar in front of the head of the press. The leaf winds down underneath the die which is attached to the head and into the roll feed attachment. This is adjusted so that it pulls just enough leaf for each impression assuring a fresh piece for each stamping. Roll leaf contains certain properties which make it possible to transfer with heat. The head of the press is therefore electrically heated and thermostatically controlled to ensure uniform temperature at all times. Machines are equipped with (Continued on page 188)



## A BRAND NEW WING . . . but we're not expanding!

Don't be fooled by our building operations. We're not floating any bond issues, just yet. We still believe in being *not too big* and *not too small*.

Sure, we've just added twenty-two hundred square feet. But to do a better job with our present facilities. Not to grow bigger. And even that is just a part of the long term improvement program that made us spend over a hundred thousand dollars on equipment . . . even during the blackest years.

We—and with us, our customers—find it good to have capacity enough to meet peak loads, equipment enough to provide the most efficient press for every type of job we tackle, staff enough—in office and factory—to do the sort of bang-up, rounded job that time has linked with the Boonton press-mark. And, we're willing to spend plenty of our earnings equipping ourselves to do tomorrow's job even better.

But we don't want to get too big. We don't go for interoffice memorandums, nationwide service-nets and similar fol-de-rols. Let those who want them, have them. We've seen too many good industries eaten up by red-tapeworms. As it is, we find a growing number of firms like to get their moldings from us because they like our way of working, like our technical service, our ability to come through in a pinch, our prices and our performance. If that's what you like too . . . you'll like to visit Boonton, where the latchstring is always out.

"A Ready Reference for Plastics."  
Written for the layman, this unique handbook explains the uses and characteristics of plastics in plain, non-technical language. Write for FREE copy.



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# MOLDING WITH RESIN BLANKS

by R. E. BRANNAN

TIME AND EXPERIENCE IN TURN CREATE A demand. New products are needed to meet the demands of industry and to make successful certain applications where known products have reached their zenith. In the early days of the plastics industry when the first phenolic materials were produced, they were limited in their scope of applications. It was only through patient, painstaking research that their uses multiplied and their commercial value became established in one industry after another. These uses broadened gradually and as the value of plastic materials was recognized, it became necessary to develop improved materials to satisfy individual requirements and to meet specific conditions.

One of the first demands was for material that would withstand more heat than those having a woodflour filler. It was met by producing molding materials with mineral fillers. In another instance it was disclosed that standard woodflour filled materials were being employed to mold parts which were subjected to a great deal of abuse or shock. This condition caused considerable trouble and breakage. Research again came into the

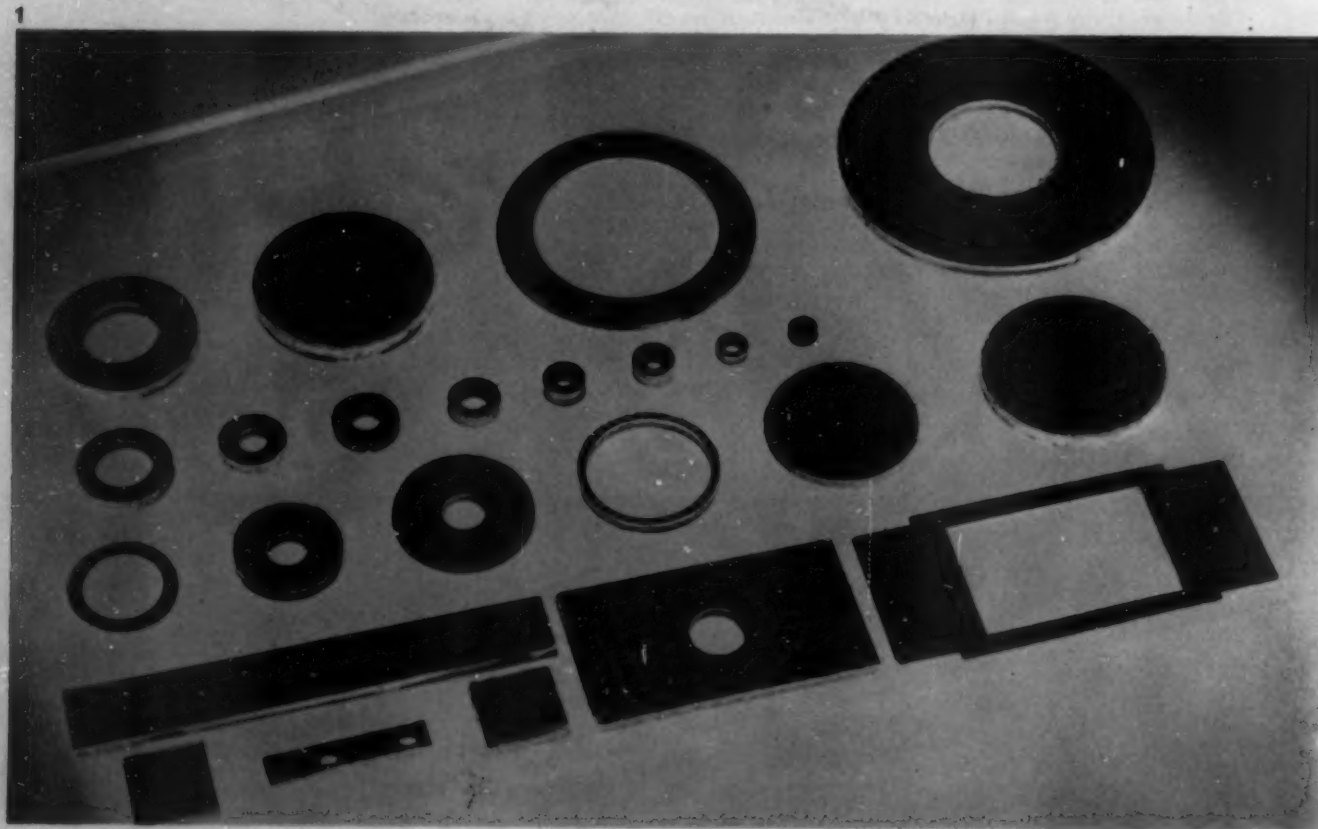
picture and developed impact-resistant fabric filled molding materials.

On the other side, running parallel with the developments in molding materials were laminated products. These materials, produced first in sheets and later in rods and tubes, differed from molding materials because of their greater strength and shock resistance. However, laminated products could not be readily molded into shapes. At the same time the general insulating qualities and high finish were similar to those attained with molding materials.

There was still a gap in between these two products. A material was needed that could be molded into shapes and still approximate the strength characteristics of the laminated materials. Here again, as in all steps of progress, the resourcefulness of research was summoned. Indicative of the improvement in shock resistance of molding materials were the fabric base products made by the inclusion of resin in rag stock.

Further development along these lines has led to the introduction of a wide range (*Continued on page 190*)

Fig. 1. A group of typical resin blanks punched from molding board. (All photos courtesy Bakelite Corp.)



# SINCE 1836...

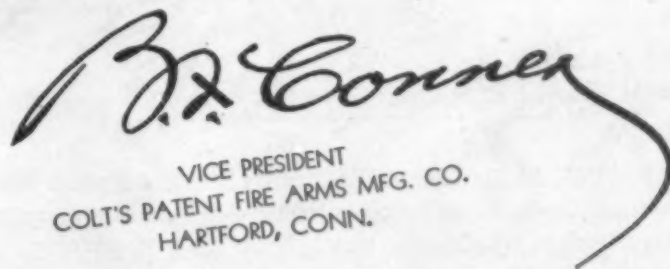
## A MAJOR FACTOR IN AMERICA'S INDUSTRIAL DEVELOPMENT

TO-DAY, COLT'S IS PROUD TO PLAY A MAJOR  
ROLE IN THE GROWTH OF THE PLASTIC INDUSTRY

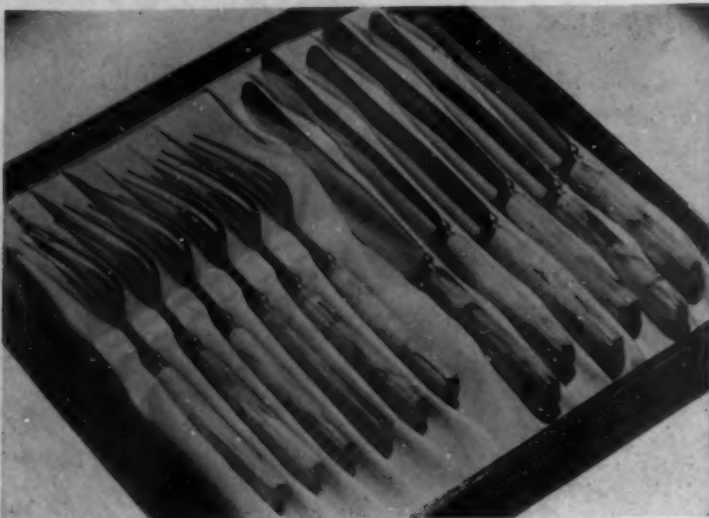
For many years now, the Plastics Division of the Colt's Patent Fire Arms Mfg. Co.  
has been growing with the growth of plastics to major industrial importance.

Starting with the industry itself, Colt's is proud to have continued among the lead-  
ers. Growth in the past years was made possible, in large measure, by discoveries  
and developments originating in the Colt's plants. And today, Colt's innovations,  
Colt's processes and Colt's designs are playing an increasingly important part in the  
expansion of plastics usage.

Reviewing the recent past, Colt's is proud indeed to have maintained its record for  
leadership in an industry so notable for its rapid development and forward-looking  
viewpoint. In the future—as in the past—no effort and no expense will be spared  
to maintain Colt's leadership in service to its clients.

  
VICE PRESIDENT  
COLT'S PATENT FIRE ARMS MFG. CO.  
HARTFORD, CONN.

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**COLT'S PATENT FIRE ARMS MANUFACTURING CO.**  
*Manufacturers of*  
FIRE ARMS—ELECTRICAL EQUIPMENT—MOLDED PLASTIC PRODUCTS DISH AND  
METAL CLEANING MACHINES  
HARTFORD, CONNECTICUT, U. S. A.



Parker desk sets (upper left) illustrate the harmonious combination of metal with cast resins. These resins are available in a variety of stock shapes (upper right) to be fashioned into innumerable decorative and utilitarian articles (lower left). Table cutlery (lower right) handles are cast in many colors to match table decoration. (Photos courtesy Marblette Corp.)

## FABRICATING CAST RESINS

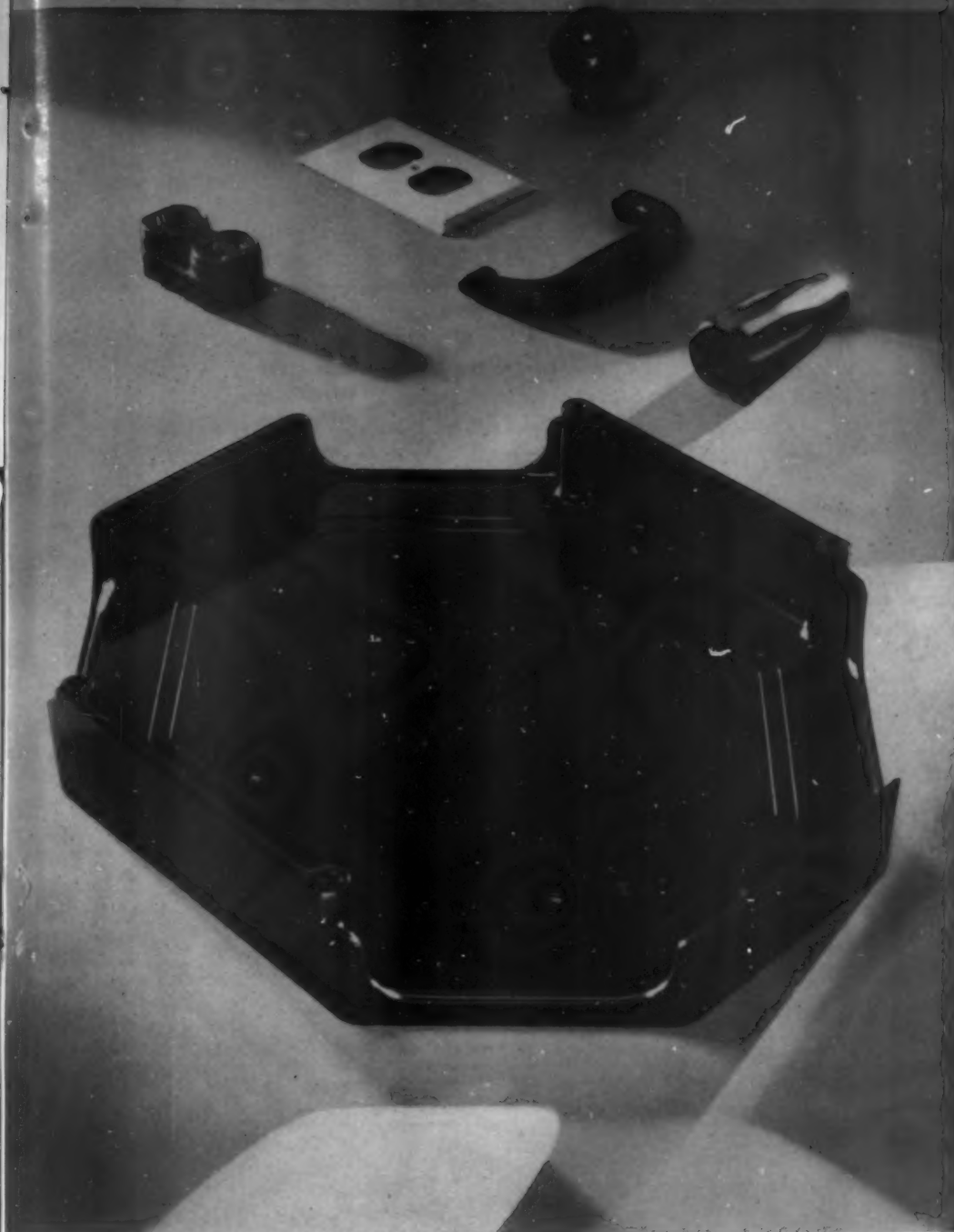
by D. J. KELLY

CAST PHENOLIC RESINS, PERHAPS MORE THAN any other plastic material, lend themselves to craftsmanship not unlike that practiced by old-time metal, bone and wood-workers. But present day requirements for speed and quantity production have developed a need for simple machinery, combined in some instances with hand work, to turn out products fast enough to satisfy the demand. In the something over ten years since cast resins were first introduced in this country, they have gradually crept into a variety of industries. Essentially decorative, with literally hundreds of different shades and colors—opaques, translucents, transparents, plain and mottled patterns—they have become established for making costume jewelry, household accessories and trimmings, cutlery handles, lamp bases, automotive fittings, architectural panels, etc., to a degree that is seldom realized by

the layman who accepts them as readily as he does any contemporary material.

A primary inducement for consideration of their use is the ease with which they are fabricated. No expensive molds are required, and changing from one design to another, or even from one type of product to another to keep in step with the caprices of public taste and desire, can be accomplished quickly with no loss of material and no occasion, in most instances, for enlarging or changing shop facilities. All that is needed, is an adequately equipped machine shop such as might be installed for metal or wood-working purposes with the addition of special machine attachments to simplify certain operations. For cast resins may be sawed, turned, drilled, threaded, embossed, carved, faceted and polished with a minimum of effort.

*(Continued on page 194)*



USUAL OR

*Unusual*

THEY'RE ALL THE  
SAME TO AUBURN

Some jobs are easy for even the inexperienced . . . many are hard for anyone. But where plastic moldings

enter the picture, Auburn Button Works is equipped to handle both with equal facility . . . and to get either out on time.

60 pioneering years in the molding of plastics gives Auburn knowledge of the little things which dwarf the difficulties of hard jobs and make possible many cost-cutting short cuts on the easy ones that do not impair quality.

Rigid inspection of every piece at every phase of manufacture safeguards Auburn's unapproached reputation for quality.

Whatever your requirements, Auburn has the facilities to meet them with complete understanding.

*Established 1876*

MOLDED PLASTICS DIVISION OF  
**AUBURN BUTTON WORKS, Inc.**  
AUBURN, N. Y.

# THE FABRICATING OF CELLULOSE PLASTICS

by L. R. BLACKHURST

FABRICATION OF CELLULOSE PLASTICS IS DIVIDED into two general classes, one in which molding powder is used and the other in which sheets, rods and tubes are used. Each method, then, requires an entirely different process to attain a similar result—the production of the finished article. In discussing the fabrication of these two types of plastics, each must necessarily be treated differently, since the process required for one has no relation to the process required for the other. This article will discuss the fabrication of sheets, rods and tubes, defining the virtues and uses of the outstanding plastics that come in that form.

The basis of these plastics is cellulose acetate and cellulose nitrate. They require hand or machine working and can be machined like wood or metal. Although the method of fabrication is so similar that processes used for one would apply very generally to the other two, each, of course, offers advantages over the other for specific uses. However, each possesses the same characteristics in the fact that a wide range of colors is available in each, and that each can be readily polished, embossed, printed, lacquered or stained and can be decorated in a great variety of ways.

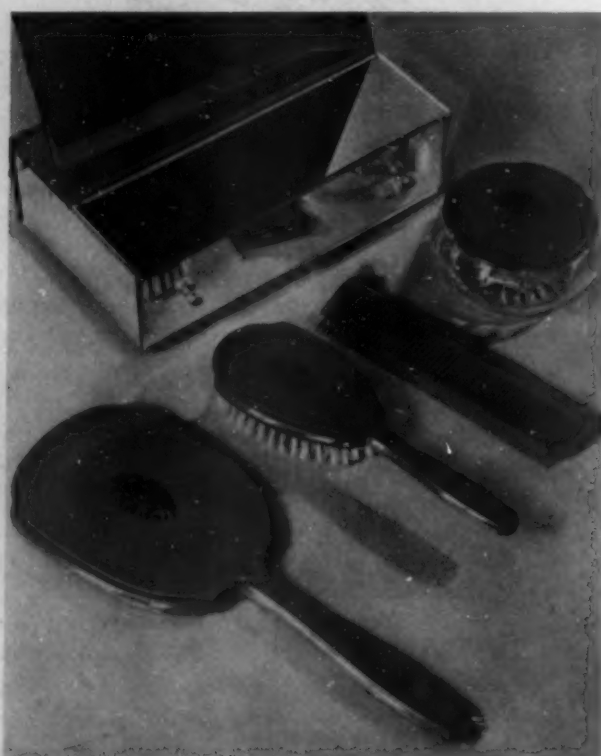
For example, cellulose nitrate plastics are inflammable and cannot be used where a fire hazard exists. They were the first of the plastics to make their appearance in this country. They date back to 1883 and have been steadily improved in quality through extensive research. They are most adaptable, are easy to work, are thermoplastic and can be readily machined, sawed, blown and molded. They are virtually unbreakable. Their most popular use is for safety glass, heel coverings to make scuffless heels, toiletware, fountain pen and pencil barrels, advertising novelties, tooth-brush handles, umbrella handles, radio dials, slide fasteners and costume jewelry, in addition to hundreds of other fashion and commercial articles.

Cellulose acetate plastics are "slow-burning," are a low conductor of heat, have no odors or taste and are unaffected by most vegetable and mineral oils. Their resistance to the effect of sun exposure makes them suitable for articles which are exposed to sunlight or outdoor use. Their transparency and the fact that any conceivable color can be obtained, including mottled, opaque and pearl effects, has given them wide popularity and usage. They present (Continued on page 200)

Toiletware of cellulose nitrate plastic with veins of contrasting color which are a part of the material itself. This pattern is called Patrician



Carved medallions and a gold edging line decorate this toilet set available in tearose, Bonnie blue, fern green and hyacinth. (All photos courtesy du Pont Style Service)



CAN YOU COMPLETE THIS PICTURE ?

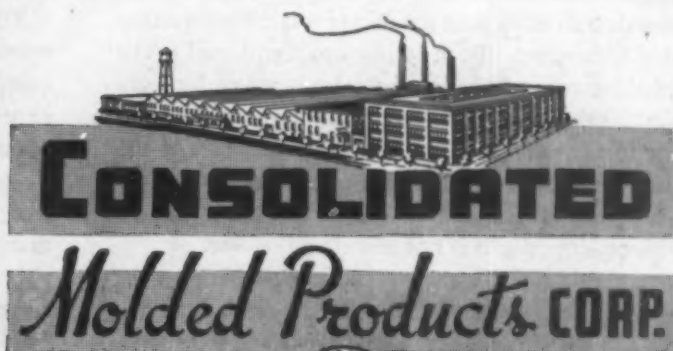


*What's Missing  
in this Illustration of  
Consolidated Molded Plastics?*

YOU guessed it! The picture is not complete without a molded part for your product.

PUZZLING problems in plastics can be solved quickly by consulting Consolidated. Plastics are not "new" to us. We've kept pace with plastic molding progress for over 50 years, and that experience plus modern equipment offers designers and product engineers a clearing house for new ideas in plastic applications.

ALL plastic materials are molded with precision for any product purpose in our presses, adhering to your specifications with uncanny accuracy.

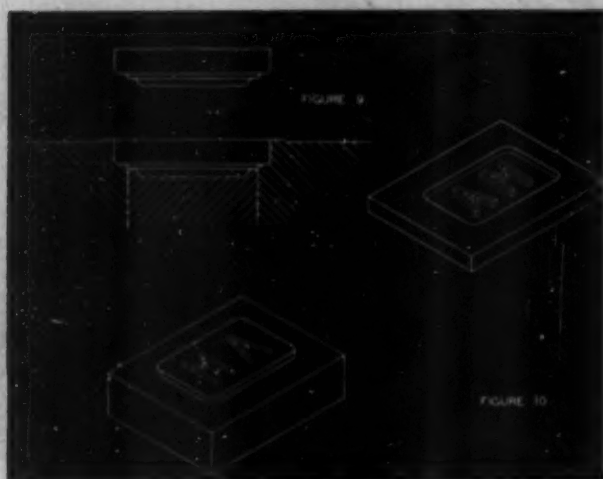


Genl. Offices and Factory: **SCRANTON, PA.**

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• Cleveland • Philadelphia •



8. Engraving letters on hobbing die



## PRACTICAL MOLD DESIGN

(Continued from page 125) of a high piece. In the mold this means either working in the bottom of a deep cavity, which is difficult, or setting in a separate section on which the details have been machined with the resultant additional fitting, etc. Both conditions mentioned in the two preceding paragraphs can be taken care of by hobbing (Fig. 8) that is, by making a hardened master and forcing it into a prepared block of special steel. In the case of multi-cavity molds this is often the best and least expensive way to proceed, but with single cavity molds and molds of large size it is not always advisable.

Whenever the mold is made up of sections fitted together, no matter how accurately the work is done the joining line will show on the mold parts. If the necessity for building the mold in this manner is foreseen the joining lines often can be concealed in either the decorative motif or along some sharp edge of the molded part. Fig. 9 shows designing which has achieved concealed joining of mold sections.

It also must be kept in mind when a mold is built in sections that proper support or backing is given to avoid the possible spreading under pressure. A spreading would result in heavy fins of material at these points.

Close tolerances contribute very materially to higher mold costs. Not only is greater accuracy demanded of the mold maker but subsequent grinding operations on the mold after hardening are often required. Even with the most careful heat treatments mold parts will distort and warp in hardening and if a surface governing a dimension with close tolerances is affected it may require many hours of stoning in a cramped area to get the required results.

Side holes, undercuts, depressed letters and figures are other factors to be avoided for reasonable mold costs and economical mold operation. With the use of combination vertical and horizontal ram presses side holes and undercuts are easily handled but the type of mold necessary is more expensive to build and operate.

Raised letters and figures on the molded part can be accomplished by stamping them into the mold while depressed letters on the molded part means the cutting of raised letters in the mold except in the case of cavities where hobbing is planned. With hobbing the depressed letters stamped into the hob will result in raised letters in the mold. If raised letters and figures are objectionable due to interference on an assembly surface they can be stamped or machined into a raised portion in the mold, resulting in a raised letter on a depressed panel in the molded part (Fig. 10).

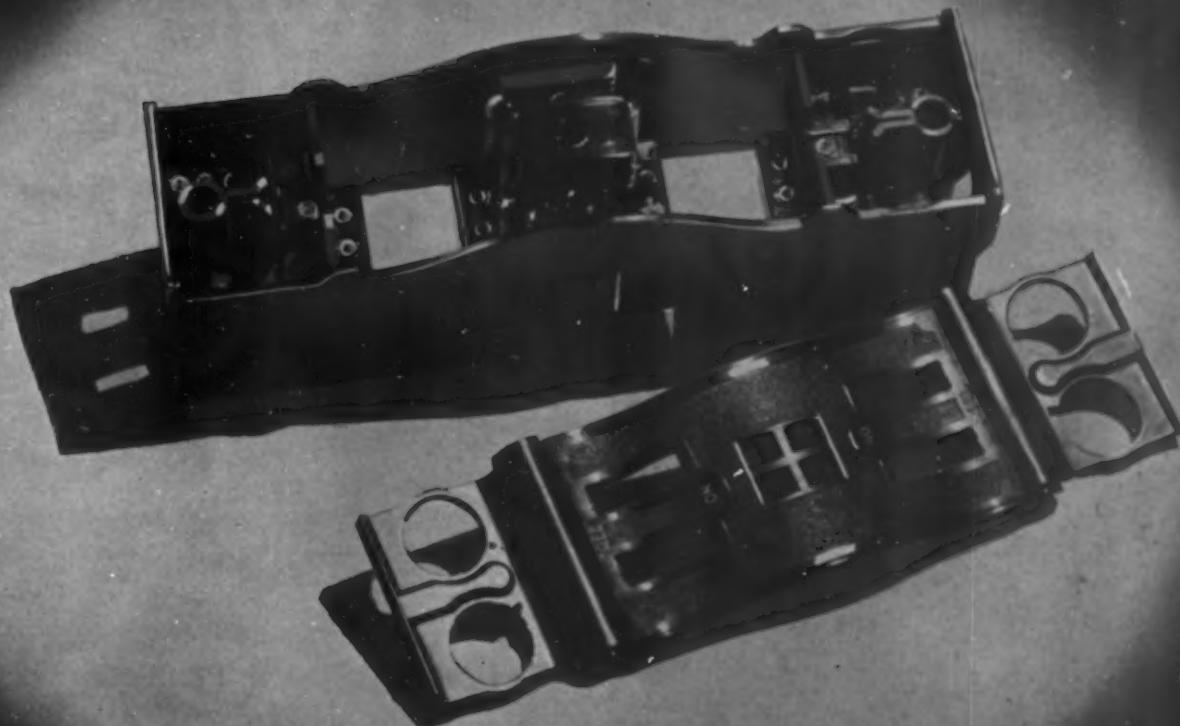
Assuming the designer of the molded part has given consideration to all of the aforementioned factors, there are other design questions such as accuracy demanded, finish, positioning of inserts, etc., which cannot be settled until the type of mold is determined.

In the modern molding plant the type of mold required is agreed to by executives of the engineering, manufacturing and tool departments. This is done after thorough consideration of the customer's specifications, the most economical machining methods, and the molding requirements. These final design changes are usually of a minor nature and are to the customer's advantage for they facilitate not only the manufacture of the mold but of the parts as well.

The type, kind and size of mold having been determined, the actual laying out and detailing is done by a competent tool designer who has a background of actual experience in building as well as designing molds. He must know the correct amount of molding pressure required, the thickness of material to withstand this pressure, the size of press, the space for loading the uncured material in the mold, ease and quickness of operation, accessibility of parts needing maintenance, proper shrinkage for the molding material selected, method of holding inserts, etc. This phase of mold manufacture is considered highly important. Errors occurring in the design are more easily corrected on paper than steel.

With the preliminaries completed the actual construction is started. Molds range from small single cavity types, weighing a few pounds, to others that weigh tons such as the 5 ton mold for the large Wakefield Reflector in Fig. 1. The manufacture of molds requires a great variety of modern precision machine tools and skilled craftsmen if accuracy and economy is to be obtained.

# *Take it up with* **KURZ-KASCH**



Right now Kurz-Kasch is molding automatic selector buttons for more than a dozen different makes of radios.

Right now they are turning out several of the most difficult parts any molder was ever called upon to make.

In short, whether it be a heavy production schedule on simple pieces like radio dials and knobs, or "head scratching" tough assignments, Kurz-Kasch has the facilities and experience required to handle the job.

Workers in bakelite, plaskon, beetle and all the other preferred materials.

**KURZ-KASCH, Inc.**

Dayton, Ohio

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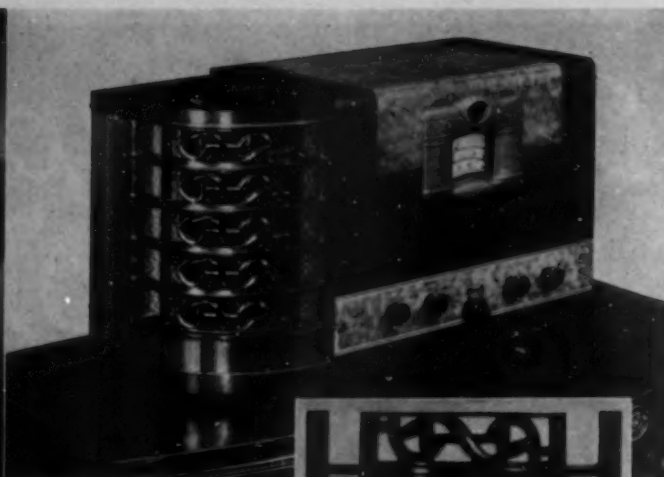
## **KURZ-KASCH Inc.**

OCTOBER 1937

155



STATIONERY BOX  
The American Stationery Co.



RADIO SPEAKER GRID  
Stromberg-Carlson



NOVEL GIFT PACKAGE  
Parker Pen

HERE ARE SHOWN  
Gorham-made plastics products created for  
such reputable concerns as The American  
Stationery Co., Parker Pen, The Patent Button  
Co., Stromberg-Carlson, General Shaver, S. H.  
Kress & Co., Colonial Radio, J. R. Brundage  
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• No matter what your plastics problem may  
be, we welcome an opportunity to prove our  
skill to you.

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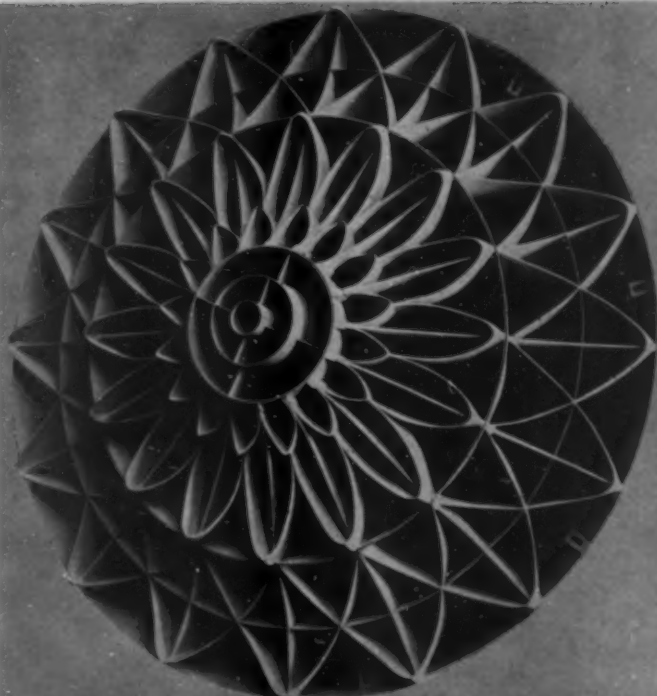
ELMWOOD STATION . . . PROVIDENCE, RHODE ISLAND



BLOTTER SET  
The Patent Button Co.

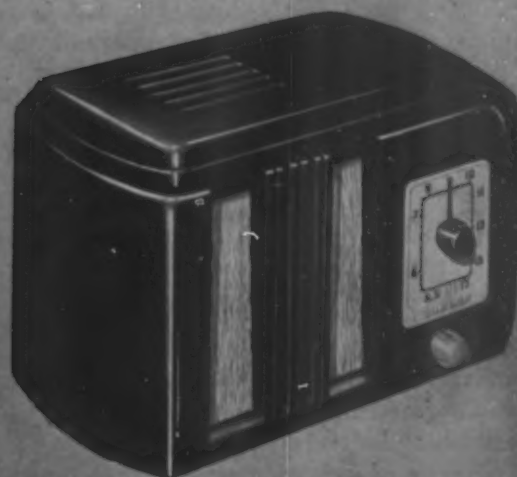
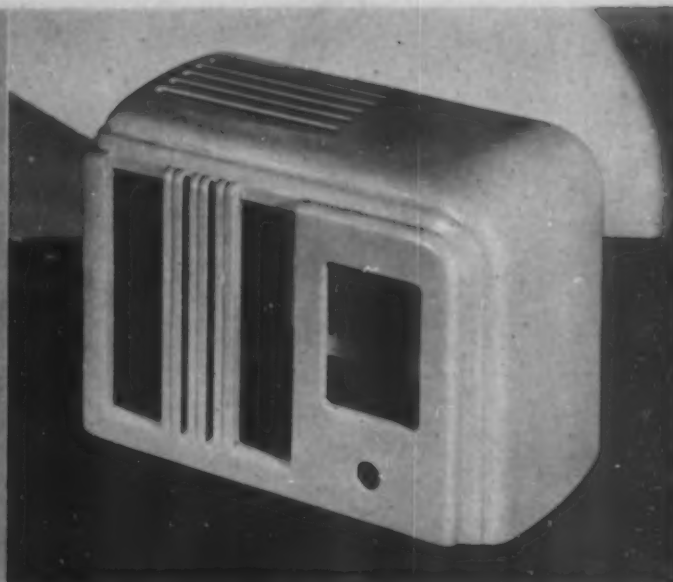


ELECTRIC SHAVER CASE  
Remington-Rand



OVERHEAD LIGHTING GRILLE—3-foot diameter  
S. H. Kress & Co.

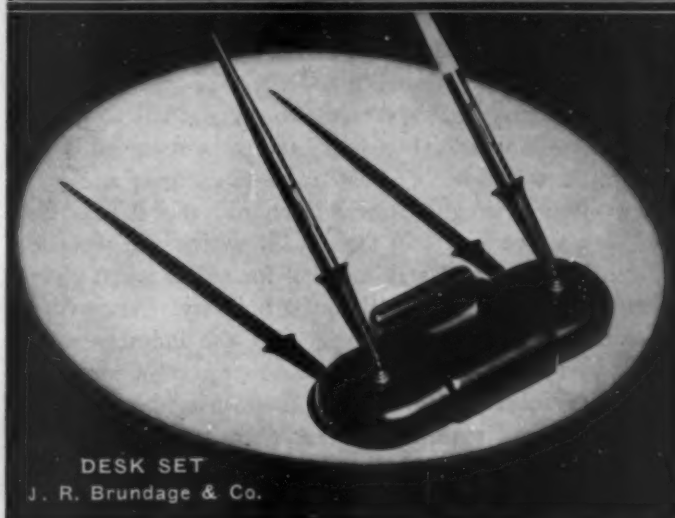
- Our filtered-air booths assure spotless color moldings whether Urea, Acetate or clear Lucite. For ultimate economy of cost and operations our steel or beryllium molds are unsurpassed.
- Gorham's staff of designers are continually creating ideas for customers. And with the finest production facilities, backed by skillful engineering, you will find Gorham capable of meeting your special requirements.



RADIO CABINET  
Colonial

## THE GORHAM COMPANY—PLASTICS DIVISION

ELMWOOD STATION . . . . PROVIDENCE, RHODE ISLAND



DESK SET  
J. R. Brundage & Co.



CIGARETTE CASE  
Gillette Razor



2. Machined mold made of Stentor oil-hardening tool steel. 3. Closure molds made of Samson mold steel. (All photos courtesy Carpenter Steel Co.)



## MOLD STEEL FOR MOLDED PLASTICS

(Continued from page 128) increase its wear resistance without necessarily increasing its heat treated hardness. Chromium and nickel combined as alloys in a steel have the property of increasing wear resistance to a marked degree, and these alloys are commonly found in the best mold steels.

D. *Ease of fabrication:* Some molds are brought to shape largely by hobbing—some are entirely machined—and some are made by a combination of both.

(1) *Hobbing:* The depth to which a hob can be driven in—and the power needed for the operation—depends very largely upon the hardness (or softness) of the mold steel when annealed. The degree of softness that may be secured in annealing depends upon the analysis of the steel. A mold steel containing no alloys can of course be annealed considerably softer than an alloy mold steel—even though the carbon may be equally low in both. Thus it happens that an analysis which is easy to hob does not make as strong a mold as a steel which is somewhat more difficult to hob. Obviously, there is no point in selecting a very soft mold steel to permit easy hobbing, if the finished tool is going to upset under the pressure of service. An alloy steel having reasonably good hobbing qualities, together with good strength after heat treatment, will be described later.

(2) *Machining:* Easy and clean machining properties are desirable in mold steels that must be machined to shape. The steel maker dare not sacrifice "cleanness" (described in paragraph A) in an effort to secure easy

machining properties. Commercial machinery steels that are high in phosphorus and sulphur are very easy to machine but they usually contain large quantities of non-metallic inclusions that will mar the finish on the mold and on the finished article. We must therefore depend largely upon careful annealing to secure the best possible machining in a given analysis of mold steel.

(3) *Heat treating:* It is necessary to heat treat the finished molds made from all steels in order to secure proper wear resistance and strength to endure service conditions. Aside from these fundamental requirements of heat treating, there are three other factors that must be carefully watched. (a) *Distortion*—In the interest of accurate dimensions on the finished product, warpage and distortion in heat treating must be kept at a minimum. (b) *Scaling*—Since the finish on the surface of the cavity is so vital to the appearance of the work, low hardening temperatures are desirable and every effort must be expended during heat treatment to prevent the formation of excess scale which would have to be removed by expensive polishing. (c) *Soft spots*—Dies must not show soft spots or irregularities in the hardness of the cavities.

The Carpenter Steel Co., with which the writer is associated, started making steel for molds when plastic molding was still an "infant" industry. These mold steels have progressed along with the industry which they serve. Problems have been met one by one as the size of molds have increased, their shape become more intricate and requirements for abrasion resistance and strength have become more severe.

Throughout these years, four separate and distinct

QUALITY

SMP

*Distinguished Molders  
of Synthetic Plastics*

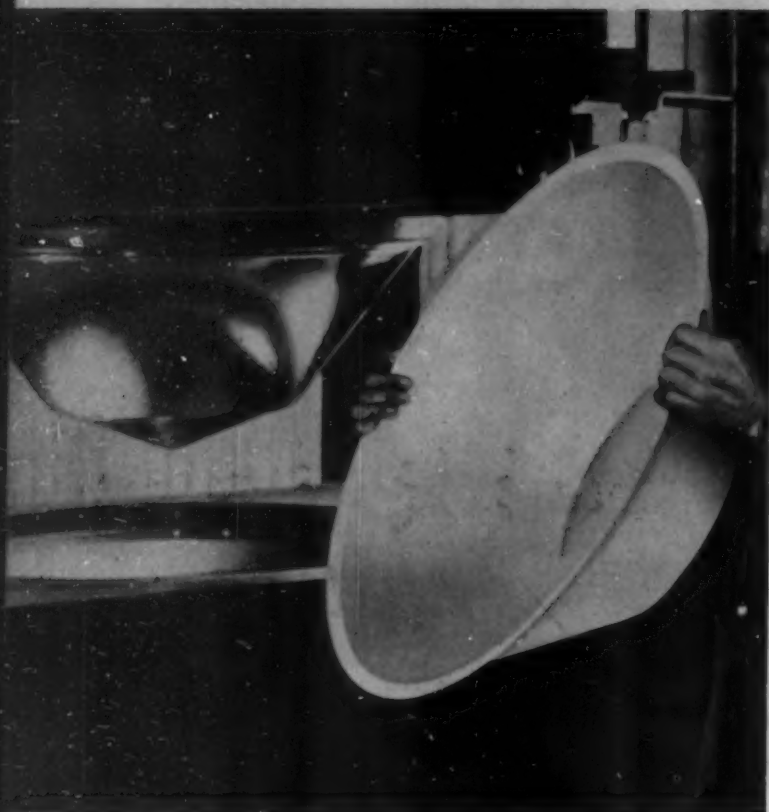
**SYNTHETIC  
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***Stonington, Connecticut***

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**BOGARDUS 4-4375**

**P.S.** Because we build the molds we work from, we have been able to save substantial sums for many of our clients on mold costs while—at the same time—protecting them against incorrect or inefficient mold design. These savings . . . plus the savings that Synthetic's skilled molders and modern machines effect . . . mean a decided lower in per-piece costs.



4. Five tons of mold steel were used in this single cavity for this 26½ in. reflector

mold steels have emerged. Three of them are low carbon, case hardening mold steels and the fourth is a high carbon tempering grade of tool steel. The properties of these four steels are summarized in Table 1.

The significance of the tabulated data may be summarized in this manner:

*Type A Mold Steel*, being a soft ingot iron free from alloys, is best suited for making intricately shaped molds where ease of hobbing is of paramount importance.

*Type B Mold Steel*, with its alloys of chromium and nickel, combines the most favorable properties for hobbled molds. It possesses good strength to resist up-setting in service, has excellent wear resistance and takes a good polish—yet it can be annealed soft enough to be hobbled into all but the most difficult shapes.

*Type C Mold Steel*, with its high alloy content possesses maximum strength for large or highly stressed molds. It should be machined into shape.

*Type D Tool Steel* is a clean sound tool steel that hardens in oil and holds size and shape accurately. It is safe to harden in intricate sections and possesses good wear resistance and compressive strength.

In conclusion, it should be emphasized that there is no universally "best" mold steel—any more than there is a "best" plastic for all purposes regardless. Maximum satisfaction and economy are to be had by selecting the *right* mold steel for each job. Sometimes the mold that is cheapest to build will be cheapest to use; but quite frequently a more expensive mold will be cheaper in the long run.

Table 1—PLASTIC MOLD STEELS

| Name               | Type A<br>(a case-hardening mold steel)   | Type B<br>(a case-hardening mold steel)   | Type C<br>(a case-hardening mold steel)   | Type D<br>(a tool steel)                              |
|--------------------|---|---|---|---|
| Type Analysis      | C .10%<br>Mn .25  | C .10%<br>Mn .30<br>Cr .50<br>Ni 1.25   | C .10%<br>Mn .40<br>Cr 1.50<br>Ni 3.50  | C .90%<br>Mn 1.60                                     |
| Cleanness          | Electric furnace melted—acid etch inspected   | Electric furnace melted—acid etch inspected   | Electric furnace melted—acid etch inspected   | Electric furnace melted—acid etch inspected           |
| Strength           | Fair (see Properties below)   | Good (see Properties below)   | Very high (see Properties below)  | Very high in compression. Fair in tension             |
| Wear Resistance    | Good  | High because of alloys  | Excellent because of maximum alloy content  | Excellent   |
| Hobbing            | Excellent<br>Brinell = 90 max.  | Medium<br>Brinell = 120 max.  | Difficult<br>Brinell = 200 max.   | Poor  |
| Machining          | Tough and stringy   | Fair-tough  | About like tool steel   | Same as high carbon tool steel                        |
| Heat Treatment     | Cyanide from 1500° F or Carburize 1600°/1630° F. Cool in box. Reheat to 1425°/1450° F. Quench in brine. Draw 250°/300° F. | Carburize 1600°/1650° F. Cool in box. Reheat to 1440° F. Quench in oil or brine. Draw to 250°/300° F. | Carburize 1600° F. Cool in box. Reheat to 1425° F. Quench in oil. Draw 250°/300° F. | Heat to 1420°/1440° F. Quench in oil. Draw to 375° F. |
| Hardness of case   | Rockwell C-62/64<br>Shore 85/88   | Rockwell C-62/64<br>Shore 85/88   | Rockwell C-61/62<br>Shore 83/85   | Rockwell C-61/62<br>Shore 85/86                       |
| Properties of Core |   |   |   |   |
| Tensile            | 58,000 lbs/sq. in.  | 85,000 lbs/sq. in.  | 165,000 lbs/sq. in.   | No core—Steel hardens clear through                   |
| Yieldpoint         | 38,000 lbs/sq. in.  | 48,000 lbs/sq. in.  | 135,000 lbs/sq. in.   |   |
| Elongation in 2"   | 33.0%   | 30.0%   | 16.0%   |   |
| Reduction of Area  | 63.0%   | 66.0%   | 53.0%   |   |

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TO THE LARGEST—

# Carpenter

## IS THE PREFERRED MOLD STEEL

Constant research, rigid inspections and close control in the making of this electric furnace steel — have enabled us to keep pace with the industry's demands for easier hobbing qualities — good machinability — cavities that take a mirror finish — and molds that will not sink or upset in service.



Four types of Carpenter Mold Steels (as listed below) are available to meet your needs. To aid you in selecting the proper type and to provide you with helpful working data, Carpenter has prepared a special illustrated Mold Steel bulletin. Write today for your free copy of this useful bulletin.

### NORSWEDE

#### Type Analysis:

|            |          |
|------------|----------|
| Carbon     | .10%     |
| Manganese  | .25      |
| Phosphorus | .03 max. |
| Sulphur    | .03 max. |

### SAMSON

#### Type Analysis:

|           |      |
|-----------|------|
| Carbon    | .10% |
| Manganese | .50  |
| Chromium  | .50  |
| Nickel    | 1.25 |

### No. 158

#### Type Analysis:

|           |      |
|-----------|------|
| Carbon    | .10% |
| Manganese | .40  |
| Chromium  | 1.50 |
| Nickel    | 3.50 |

### STENTOR

#### Type Analysis:

|           |      |
|-----------|------|
| Carbon    | .90% |
| Manganese | 1.60 |
| Silicon   | .25  |

THE CARPENTER STEEL CO. • READING, PA.

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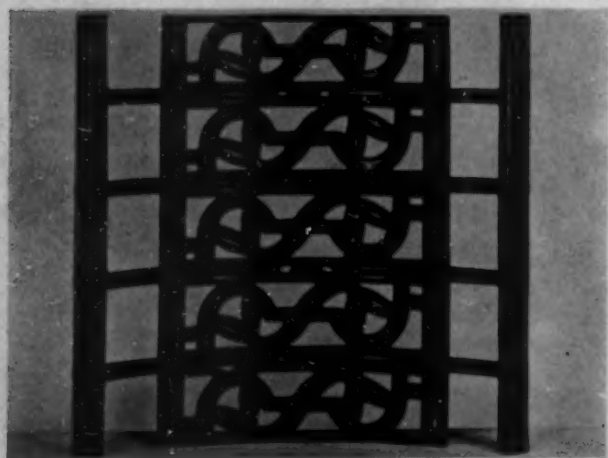
St. Louis

Indianapolis

## BERYLLIUM COPPER ALLOYS

(Continued from page 130) tified as an element in 1797, over a century went by before more than a few grams of the metal were ever produced. Unfortunately, when enough was available for careful study it was discovered that the element appeared to lack ductility and could not be rolled. Perhaps metallurgical research will surmount this obstacle, as some investigators claim that small amounts of impurities cause this brittleness, but at any rate for the time being it seems that the use of beryllium is restricted to the addition of small quantities to other metals for hardening or scavenging purposes.

Casting a mold from a pattern close enough to finished size so that only a small amount of finishing would be required is by no means a new idea to the plastic industry, but up to now no metal has been known which would fill all the requirements. It was realized that a cast mold would have to be made from a material which would be readily castable, which would have a minimum of surface defects, and above all, which would have sufficient strength to stand the pressures involved in forming plastic articles.



The introduction of beryllium copper to this field appears to offer the closest approach to the attainment of this ideal which has so far been reached. Castings containing approximately 2.75 percent beryllium, balance copper, offer the following advantageous characteristics:

(a) The alloy has a relatively low melting point, compared to metals of equal strength, and, when properly handled, flows as well as the best of casting bronzes, giving excellent reproduction of detail and a relatively smooth surface, which can be readily polished by chasing and buffing.

(b) The castings can be heat treated to a compressive strength of approximately 190,000 lbs./sq. in. with a hardness of about 42 Rockwell C.

(c) Beryllium copper molds have a thermal conductivity more than twice that of steel, which enables shortening the molding cycle.

An impressive example of the economies that may be achieved through the proper application of beryllium copper molds is shown in Fig. 1. This radio cabinet grille, which is being produced in phenolic material for the Stromberg Carlson Company, is  $9\frac{3}{4}$  in. wide by  $9\frac{1}{4}$  in. high, of curved contour, the depth of camber being  $3\frac{1}{2}$  inches. Note the irregular contours of the grille bars. The piece weighs approximately 9 ounces. Particular attention should be directed to the rear view. It will be noted that the back of all the grille bars are hollowed out to save molding material and weight. The approximate saving in weight of both material loaded and finished piece by coring the back is 39 percent. Using conventional steel mold machining technique, excessive time would be required and considerable difficulties encountered in machining the irregular contours and in cutting out the back. The piece could undoubtedly have been molded just as satisfactorily in steel, but at an enormously increased mold expense. Since in this case the number of pieces desired was moderate, the amortization of mold cost in steel would have been prohibitive.

Another example of the possible economy in a cast beryllium copper mold is illustrated in Fig. 2. This piece, shown just as it is removed from the mold, is a helmet used with the "Aerocrat" hair dryer, sold to beauty shops and hair dressing establishments. This is one of the largest pieces of its kind ever molded. It is made from a phenolic material and is 18 in. long,  $11\frac{5}{8}$  in. wide and  $10\frac{1}{4}$  in. deep, weighing over four pounds. Steel mold quotations received by the manufacturer of the hair dryer assembly were too high for the approximate five thousand pieces over which the mold had to be amortized. The beryllium copper mold cost about 60 percent of the average steel mold quotations.

Comparing this helmet with the small parts shown in Fig. 3 will give some idea of the wide range of sizes, designs and shapes to which beryllium copper cast molds are adaptable. The parts of the butterfly shown in Fig. 3 weigh about one gram each.

Selecting one case from the several histories available concerning the use of a beryllium copper mold over a fair sized production run in compression molding, attention is directed to Fig. 4. This box cover was produced from

**BEZELS\***



TRADE MARK REG.

A creative design, engineering and production staff that has pioneered many of the advances in injection molding and that produced two award winners in the First Modern Plastics Competition is at your call.

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PLASTICS DIVISION  
ERIE, PENNSYLVANIA

\* U. S. AND FOREIGN PATENTS PENDING

# ERIE

## *Injection Molded*

# PLASTICS



**KNOBS**



**DIALS**





5



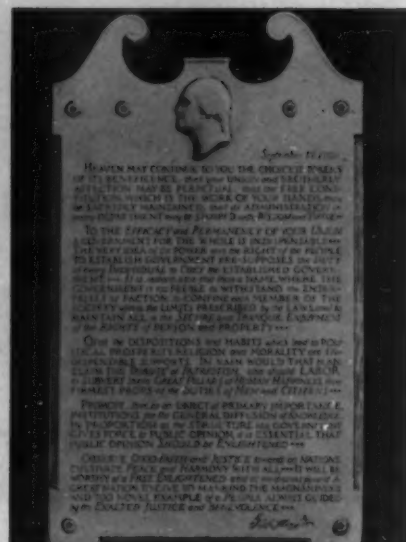
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8

one of the earliest molds cast in beryllium copper, its dimensions being  $7\frac{3}{4}$  in. by 6 inches. The mold has been in operation in four widely-scattered molding plants, and a total of over 12,000 impressions have been taken from it up to August 1, 1937. Of course, 12,000 pieces is a relatively short run for many steel molds, but in this case it is interesting as a proof of the durability of beryllium copper when subjected to variable methods of handling in several molding plants. A recent examination of this particular mold showed no noticeable wear or distortion. The original cost was 35 percent less than average quotations for a similar mold in steel had been.

Illustrated in Fig. 5 are two single cavity experimental beryllium copper molds for an unusual clock case. It should be noted that these are not split molds, rather, the cavities for the top piece and the housing are each one piece, and were so cast. The housing is  $7\frac{1}{2}$  in. in diameter at the bottom flare and  $3\frac{1}{4}$  in. in height. This example is particularly interesting as an indication of the potentialities of incorporating, without excessive cost, unusual design or ornamentation on the side wall of molded pieces, where the shape or contour of side wall is within the limitations of molding technique.

Other types of applications where cast beryllium copper molds have been used are indicated in Figs. 6 to 8, inclusive. The approximate savings on the single cavity molds used for forming these pieces as against duplicate molds in steel were approximately as follows:

|                         |                             |
|-------------------------|-----------------------------|
| Fig. 6 Frog ash tray    | 60 percent lower than Steel |
| Fig. 7 Mask             | 50 percent lower than Steel |
| Fig. 8 Farewell address | 40 percent lower than Steel |

Certain of the above molds could, of course, be readily hobbled in steel and accordingly, would be less costly than the beryllium copper molds, but only where several cavities of each part were needed.

Although beryllium copper cavities have undoubtedly advantages for certain types of compression molding, it is in injection molding that the greatest number of these cast molds have been sold and that the outstanding success has been found so far. Due to the present limitations in the volume of plastic material which can be handled in one shot on an injection machine, the molds are usually small in overall dimensions and normally incorporate only from one to eight cavities. In many cases, particularly where ornament or decoration is involved, it has been found that the few cavities required can be cast considerably cheaper in beryllium copper than they can be hobbled in steel. Furthermore, the usual small size of these molds and the fact that many of them are merely simple female cavities backed up with a flat plate means that closer dimensions can be held and more faithful reproduction of detail obtained in the casting than is possible when a large die assembly using both force and cavity is involved. It should be pointed out that the best mold materials for casting molten metal have a definite size limitation at the mo-

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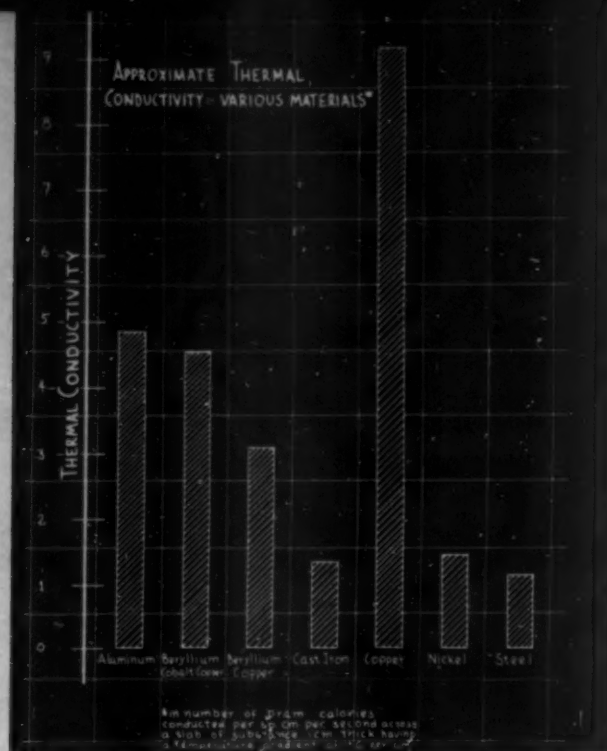
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ment and accordingly a rougher surface with more finish-machining must be expected where large cast dies are required.

One manufacturer who is making small ornamental birds and animals in injection molds reports that several million pieces have been made without damage to the beryllium copper. In numerous cases additional advantage can be found by casting the water lines for cooling integral with the mold itself.

Up to the present time the chief interest of the plastic industry in beryllium copper has been centered on the use of the alloy for cast molds. Certain other uses are in an experimental stage and should be briefly mentioned. A number of tests have been made with cast hobs made from this material. It is a startling fact to find that a copper alloy can actually be forced into steel, but such is the case. In Fig. 9 is shown a beryllium copper cast hob approximately  $2\frac{3}{4}$  in. by  $1\frac{1}{4}$  in. which on test has made five cavities  $\frac{1}{2}$  in. deep in several different types of low carbon hobbing steels. The pressures ranged from 250 to 350 tons. No significant change or distortion in the beryllium copper could be found after these impressions were made. Although a cast hob will not, of course, give as sharp detail as machined steel, this should prove a valuable short cut in die-making technique.

The high thermal conductivity of beryllium copper has perhaps not been sufficiently recognized by the molding industry. Fig. 10 gives an interesting comparison of the heat conductivity of various materials. Definite evidence is available that in compression molding of thermoplastics the production cycle can be speeded up considerably by the use of beryllium copper. One plant reports faster molding of phenolics using cavities of this alloy in place of steel. Trials are under way on the use of cavity plates made from beryllium cobalt copper, a somewhat cheaper alloy of lower strength but even higher thermal conductivity. In injection molding there is at



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present a great deal of interest in finding more effective means of uniform temperature control both in the mold and in the injection cylinder.

A list of possible uses for beryllium copper in the field of plastic molding is given below. Some of these are already being tried out, others are only suggested:

#### FOR COMPRESSION METHOD OF MOLDING

- Molds
- Mold frame or chase
- Platens
- Hydro cylinders
- Hydro rams
- Ram and cylinder packing rings

#### FOR INJECTION METHOD OF MOLDING

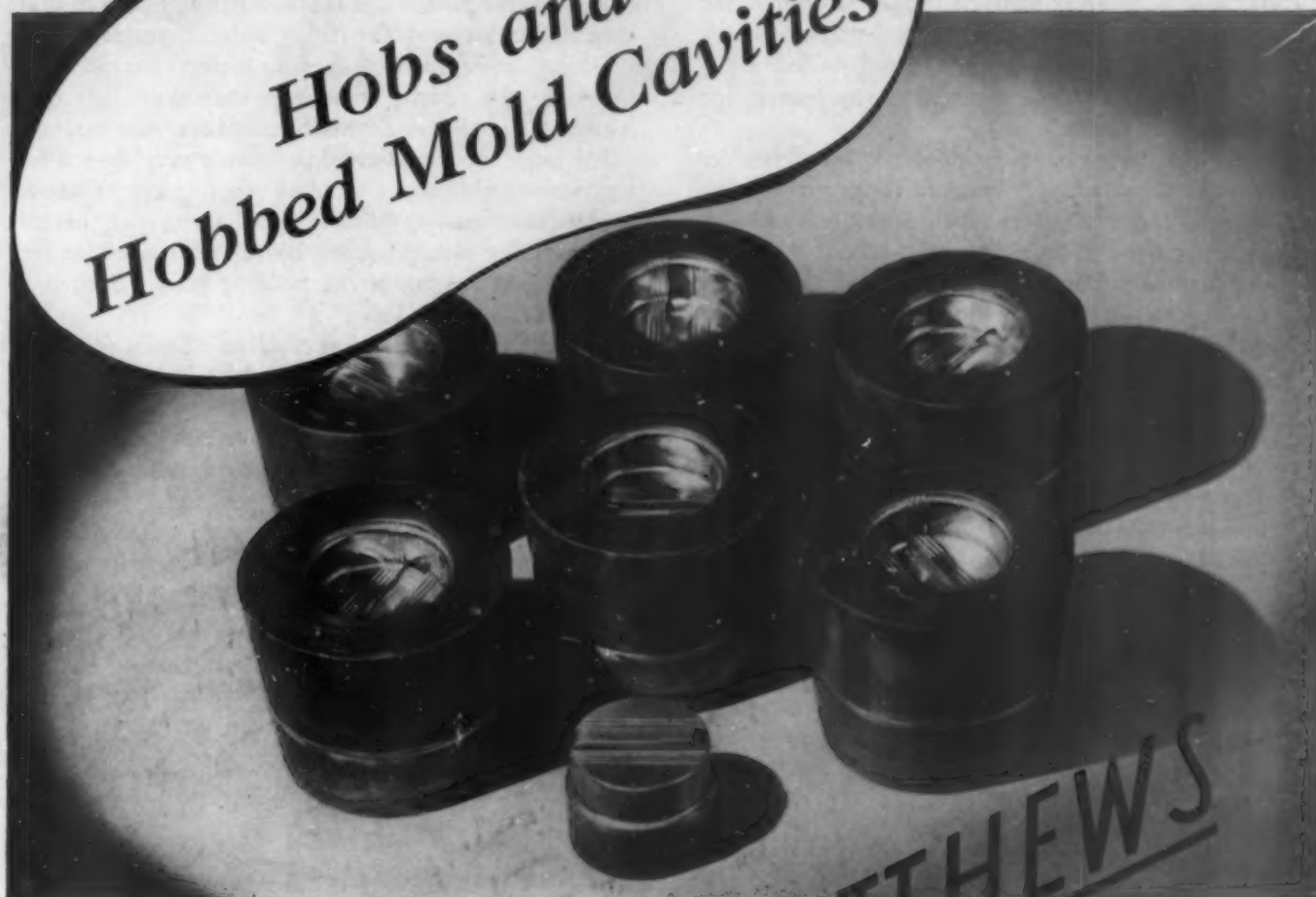
- Molds
- Mold or die mounting plates
- Heating cylinder and torpedos
- Heater nozzle
- Injection piston

#### FOR PLANT AND TOOL EQUIPMENT

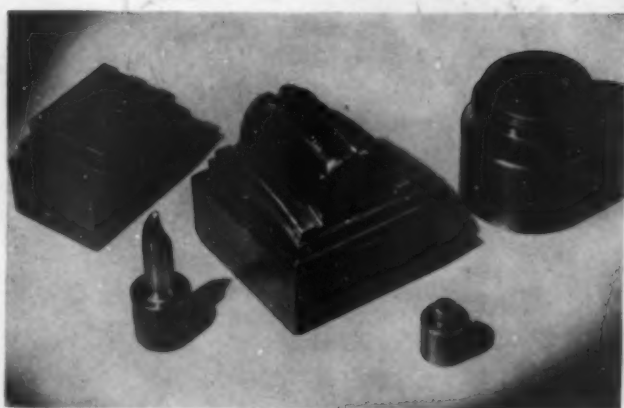
- Pump valves
- Pump valve springs
- Pump valve seats
- Accumulator ram and cylinder
- Accumulator packing rings
- Hobs
- Preform machine dies, cams, etc.

It is apparent that this new copper alloy, combining as it does a high thermal conductivity with the hardness and toughness of an alloy steel, a combination unavailable in any other material, is destined to grow considerably in importance as more engineers learn how to take advantage of its remarkable characteristics.

# Hobs and Hobbed Mold Cavities



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Hobs produce accurate mirror finished multiple mold cavities.

Facilities enable us to offer unusual size and shape cavities.

We can supply hobbed mold cavities in rough outside dimensions or finished, hardened and polished.

Send samples or drawings.

Quotations furnished promptly.

## JAS. H. MATTHEWS & CO.

3729 Belmont Avenue

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OCTOBER 1937

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## PREPARATION OF RAW MATERIAL FOR MOLDING

(Continued from page 132) and below the mandrel. Theoretically the mandrel is under no up or down stress because the mold is closing equally from both sides. A circular disc with holes through it may be compressed from powder to ease the molding of a distributor block having inserts and pins going through and out both ends. Small circular pills can be made with one hole in the center for special pieces.

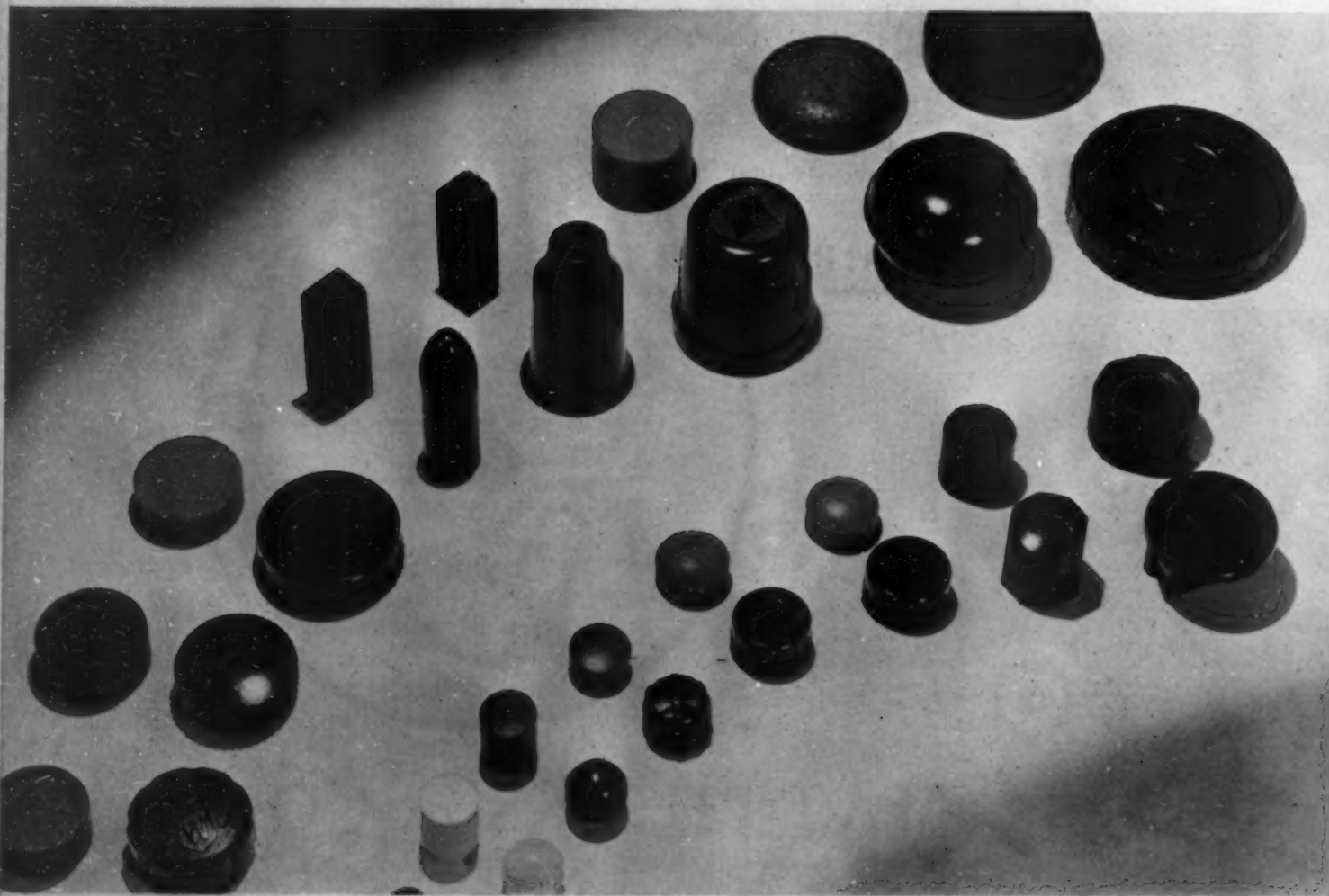
The calls for these various types of compressed powder forms have led machinery manufacturers to develop several types of presses. The single punch machine is a modification of the power punch press with a few quick motions for the feed and a hopper to ensure continuous flow of the material. The fact that it has a single punch permits various shapes to be made, just as in sheet metal punching. The press has a tubular die, a lower punch which retracts to allow a definite filling space and after the compression stroke raises flush with the die surface to permit the brushing off of the completed pill before dropping immediately to its filling position, and a top punch which merely applies the downward blow. Beside these there is a hopper for the material and a feed shoe connected to the hopper. It literally is shaped like

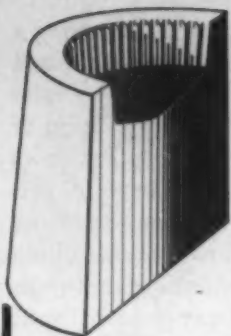
a shoe. The heel is the pivot point, the ankle opening where the material flows in from the hopper, and the toe with a hole in the bottom moves quickly in to wipe the pill off and load the cavity between strokes. These machines are geared to a production of between 40 and 60 operations per minute and it is fascinating to watch that shoe dodge between the punch and die, staying there until it seems impossible to get out in time to avoid being smashed. Of course, sometimes they don't get out, which is annoying to the machine and operator too.

For large and complicated preforms a very slow moving press—practically a standard molding operation—is used with several cavities to speed its output, loaded automatically from a loading board as described for the loose weight feeding of the molding press. Such preforms are called biscuits.

For real speed production of identical pills for large run work the rotary press is a necessity, built in sizes graduated to the diameter of pill to be made and, in the larger diameters, also modified for various pressures. A speed control mechanism in the drive is needed to gage the output to the difficulty of the operation. The resultant production has a range from 125 to 350 pellets per minute. A moderate size would be the single hopper 24 gang machine with a maximum diameter die of about

Here you see a variety of molded products (two front rows) while directly behind each is the preform or "pill" from which it was molded. (Photo courtesy Boonton Molding Co.)

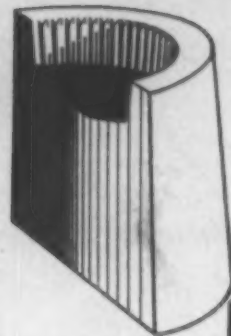




# **H O B A L I T E**

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## **H O B B E D M O L D D I E S**



This remarkable metal has been carried forward in hobbing operations by Hobbers to depths and areas heretofore considered impossible. Extensive research work has been made to ascertain the action of HOBALITE under the floor of the hob, and ways and means were tested to keep resistance nearly uniform, so that resistance and compression would be constant at all areas of the floor of the hob, and thus keep an equalized condition, which greatly helps to prevent hob breakage, tearing and galling.

Heat treating of Plastic Mold Dies was another problem delved into to ascertain the cause and corrections of sinking, deformation, and change of size.

### **PRK for MACHINED MOLD DIES**

This highly alloyed tool steel contains nine outstanding characteristics: Still Air Hardening, Minimum Deformation, High Hardness, Non Scaling, High Compressive Value, High Abrasive Resistance, Heat and Corrosion Resisting, Very High Polish, Grinds Super Keen. Each characteristic is directly applicable to a fine and high productive Plastic Mold Die Cavity.

We help your costs to a moderate total by casting PRK, leaving a minimum of machining, and frequently only a grinding operation for the cavity finish.

### **H O B   S T E E L S**

**NEOR**

**HARGUS OR-H**

**DO-IT**

Steel for hobs must contain high compressive strength, high hardness, high polish, minimum of change of size and deformation in heat treating.

NEOR and HARGUS Brand H both contain these features, but if pressure develops per inch in the maximum range, namely, 220 tons, NEOR is recommendation No. 1, owing to its deeper hardening, and HARGUS Brand H is No. 2.

When cavities are narrow, long and deep, the above physicals become secondary to a high elastic strength, so in that class of hobs we recommend DO-IT.

**DARWIN & MILNER, INC.   ZIV STEEL & WIRE CO.   H. B. A. STEEL CO.**

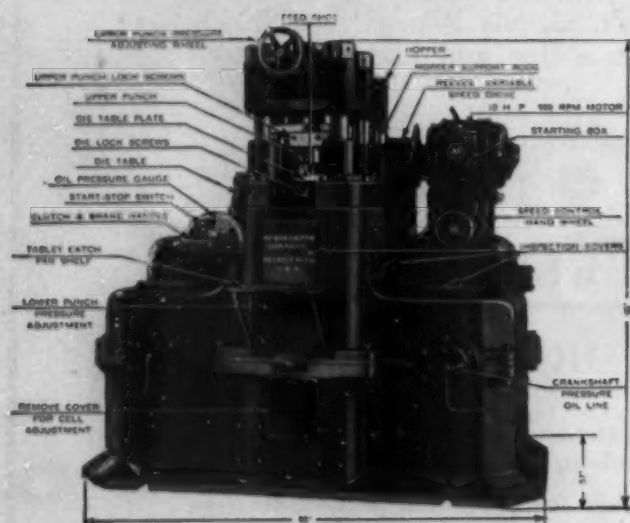
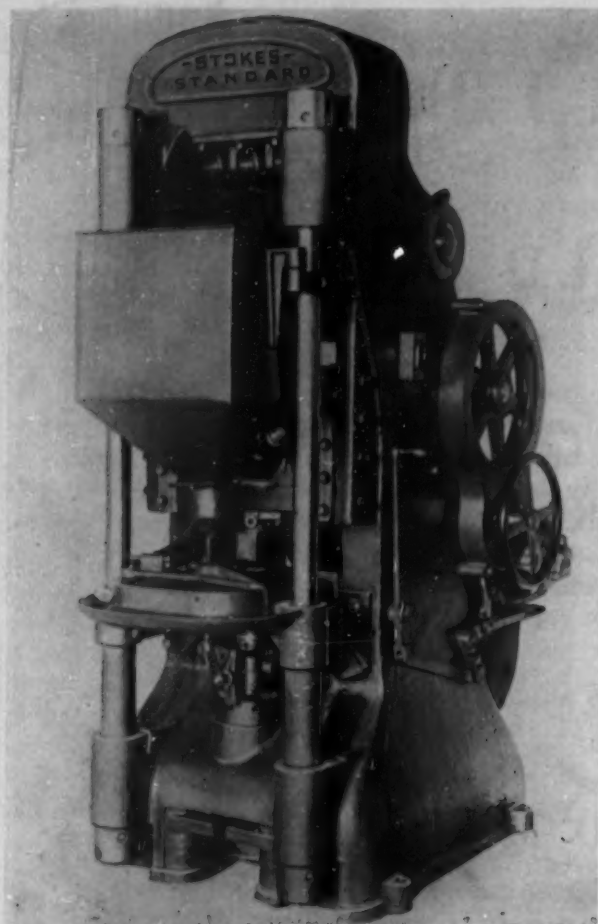
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Above is a standard type single-punch preforming press. (Photo courtesy F. J. Stokes Machine Co.) and below is a new 150-ton dual compression preforming press which applies pressure to both sides of tablet at once. (Photo courtesy Arthur Colton Co.)

$1\frac{7}{16}$  in. The die sets can be changed to allow a definite range in diameter and the punch movement can be regulated to get pills of various thickness and hardness. The thickness is determined by how far down the lower punch drops to take the material and the hardness by how far the upper punch comes in the compression action of the machine.

Basically the rotary press is a revolving table having a series of die holes along its outer edge, a series of top and bottom punches whose heads run in trackways to raise or lower them at the proper point of the revolution of the table. Starting at the point where the hopper allows the powder to flow down on the table, a series of stationary baffles smooths the material into the dies whose lower punch has been retracted to allow a proper filling space. At a later point of the revolution the upper punches ride down under a cam and apply pressure to the loose powder in the cavity. As they are lifted back out of the way by their trackway the lower punch comes up and the pill is wiped off. The hopper starts the operation over again.

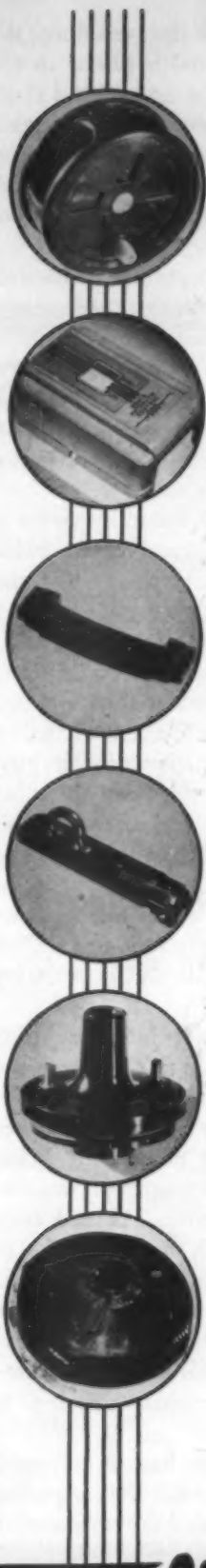
The more fibrous the material the more difficult to get it to flow through the hopper and to get a smooth fill in the die cavity. Slowing down the speed of the action permits preforming up to a certain point but beyond that nothing will give a set weight, or even a presentable and usable preform.


Fibrous materials where a preform is absolutely necessary must be molded cold by an operator after hand weighing. Where a mold was originally built for dense materials and fluffy materials have turned out to be necessary such hand made preforms are indicated regardless of their high cost. Thick sections of canvas base, which needs a five to one ratio of filling space to final molding room would require an excessively high and heavy mold if preforming were not used to reduce the filling space.

Since the molder is spending very close to thirty-five cents out of every dollar he takes in for his basic raw material, the storage, handling, control of the thousands of pill and cup weights, and in general the job of keeping track of that volume of material so that no unnecessary wastage occurs is a man sized one. The boss of materials must be an accountant, a cost expert, a mechanic, and enough of a chemist so he won't be talked down by the raw material men when something goes wrong on a job. A man of these qualities plus extensive experience in molding is really a necessity for a successful molder. Up-to-date equipment is basically needed but the personnel of the organization that keeps it running is even more important. A good man can do wonders with little equipment but the best of equipment is useless without the expert touch. No run-of-mine foremen can be trusted with control of thirty-five percent of income.

The importance of pilling has been recognized by the suppliers of raw material and most of them now have pellet machines on which they actually try pilling some of the material from each batch as it is made.

In the olden days when material would not stick together well enough to make a good firm pill, the common practice was to allow the open drum to stand where it could absorb moisture. This worked especially well in rainy weather. Now-a-days the control chemist keeps a close watch on his compounds to make sure that the molder does not have too much trouble making pills. Needless to say the actual upkeep, cleaning and repairing of the pill machines is very important. The pill machine is the heart of the molding plant.



Several of the many Industries  
to whom the  Trademark  
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RECREATIONAL

CONTROLS INDUSTRY

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*Eclipse*

**MOULDED PRODUCTS COMPANY**

MOULDERS OF . BAKELITE . DUREZ . RESINOX . TENITE . BEETLE . PLASKON

DETROIT

Factory and General Offices  
**MILWAUKEE, WIS.**

CHICAGO

OCTOBER 1937

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## COMPRESSION MOLDING

(Continued from page 136) semi-automatic type, in which heat is delivered directly to the mold itself.

On the hand press, the platens are permanently fastened to the head and bed plate, and are usually channeled with steam lines, so that the heat is applied to the mold by radiation. Since the mold is not attached to the press, but simply rests between the platens, it must be removed from the press and opened by hand for charging and discharging. Therefore, this type of press is usually employed for the shorter runs in which press time is secondary to mold cost. Jobs having several side cores entering at angles offer too many complications for the semi-automatic press.

In the semi-automatic type of press, the upper half of the mold is attached to the head, and the lower half to the bed plate mounted on the ram. The mold itself is channeled, and so heated directly from the steam lines. The mold opens with the lowering of the ram, thus facilitating charging and discharging, so that this type is usually better suited for quantity production.

The basic design of both hand and semi-automatic presses is substantially the same. Within a heavy, cast-steel base is the movable ram or plunger on top of which is fastened the platen or bed plate. When oil (or water) is pumped into this bowl, the ram is forced upward for the closing operation. The inverted-ram press has the cylinder mounted at the top, so that the head, instead of the base, travels. Double-ram presses exert pressure from both top and bottom. These, however, are used principally in extrusion molding.

Molds, like presses, are of two types: hand and semi-automatic. In each of these types are three classes: positive, semi-positive and flash or overflow. In the positive type mold, full pressure is exerted on the piece being molded. Excess material is forced up vertically between the plunger and the sides of the cavity, into a horizontal opening for that purpose.

In the semi-positive type, the plunger telescopes just far enough into the yoke to exert positive pressure only during the last small fraction of an inch which the plunger travels. Thus no flash line is needed, since the excess material flows out around the sides of the plunger. Flash or overflow molds have only natural well or yoke for the material, with no telescoping parts.

Which type of mold to use can be determined only from a careful study of the blueprints and specifications of the part to be molded, by engineers who thoroughly understand all the factors involved. Let us assume that the correct type of mold has been designed, built and delivered to the molding room. If it is of the semi-automatic type, it is carefully installed on a press of the correct capacity by the die-setter, who also connects the steam lines.

If phenolic materials are to be used, a temperature of 350 deg. F. is usually required; for ureas, the usual temperature is 300 deg. In some instances, however, either higher or lower temperatures may be used on both.

Before a new mold can be used successfully it must be

lubricated with beeswax. When this has been done, the estimated amount of material required is placed in the mold, which is carefully closed. The first several shots are purely experimental to determine first, the exact amount of material required, and second, the length of time required to cure properly. Parts are made with various lengths of curing time, and with some variations in heat and pressure.

The final samples are carefully inspected to discover flow marks in the material, blisters in the finish, warpage, and are checked for correct dimensions. Sample parts are subjected to strains until broken, and fractures are examined to make sure, especially in thick sections, that proper cure has been given. Pieces of phenolic material can be tested by placing in acetone. If the part is undercured, the acetone turns purple.

The cure of urea materials can be tested by either of two methods. In the baking test, castings are baked for sixteen hours at 140 deg. F. At the end of this period, they will show no warpage or surface cracks if properly cured. In the boiling test, castings are boiled for fifteen minutes, and then immersed in cold water for five minutes. The surface of the castings should remain solid and free from cracks, and should not turn chalky. This boiling test destroys the quality of the piece for further use, and pieces so tested must be discarded.

Castings may be weighed before and after the boiling test, and should not show more than .020 gram per square inch moisture absorption. Parts requiring an extra smooth finish must be chilled before removal from the mold by forcing cold water through the steam channels. A drop in temperature to 260 deg. F. is necessary, as a rule, in such cases.

Each type of molded piece presents its individual problems, which must be carefully worked out by foremen of long experience before the mold can be put into production. The type of material used, for example, has a very important bearing on the molding procedure. Where great impact or shock-resisting strength is required, macerated canvas—or paper-base material is used as the filler. Some asbestos-filled phenolic materials, for example, will require a longer curing time than material with the standard woodflour base. Again, if this same piece is molded of a urea material, it requires not only a longer curing time, but also a lower temperature—about 300 deg. F., instead of the usual 360 deg. for phenolics which is required.

It often happens that air and gases become trapped in the mold, forming bubbles or blisters. This is particularly true of the asbestos and macerated canvas materials. Sometimes this condition can be overcome by placing the material in a different place in the mold, so that the gases can flow out ahead of the material. Another procedure often used, is to preheat material which has been preformed, for about ten minutes in an oven at about 250 deg. F. This drives off the gases from the material.

With ureas, which are more gassy than the phenolics, a breathing operation is often necessary. After the material has been placed in the mold, the mold is slowly closed within about  $1/16$  in. (Continued on page 174)

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(Continued from page 172) of being completely closed. Next, the mold is opened slightly, so that the gas can escape freely. Then, finally, the mold is completely closed for the curing operation.

The molding of acetate materials is a somewhat different problem. The mold must be heated to a temperature of about 300 deg. F. After the material has been placed in the mold, it is closed very slowly, since it requires from fifteen seconds to one minute for the material to flux. Then, before the piece can be removed, the mold must be chilled to about 125 deg. F. so that the material will not stick. It will thus be readily seen that the acetates require much longer for compression molding than either the phenolics or the ureas, and for this reason, the injection molding process is favored for this material.

While the exact details of any molding job can be worked out only by an expert molder, there are a number of basic features which the engineer should keep in mind to get the best results from compression molding.

As will be readily seen from the foregoing description, pieces for molding should be designed, insofar as pos-

sible, so that the plunger can proceed in a direct line into the cavity or yoke, and can be withdrawn in the same manner. This, of course, means the avoidance of undercuts (as in Y<sub>3</sub>) and other lateral projections in the plunger. While in many cases lateral openings can be molded by the use of split cavities, these are both complicated and costly, and should be avoided if possible in the original design.

Provision must also be made for withdrawing the plunger and the piece from the mold. Thus the sides of the yoke should not be absolutely vertical, but should taper slightly outward, from the bottom to the top. A taper of .003 inch to each inch of cavity depth is usually sufficient, although it can, of course, be made as much greater as desired.

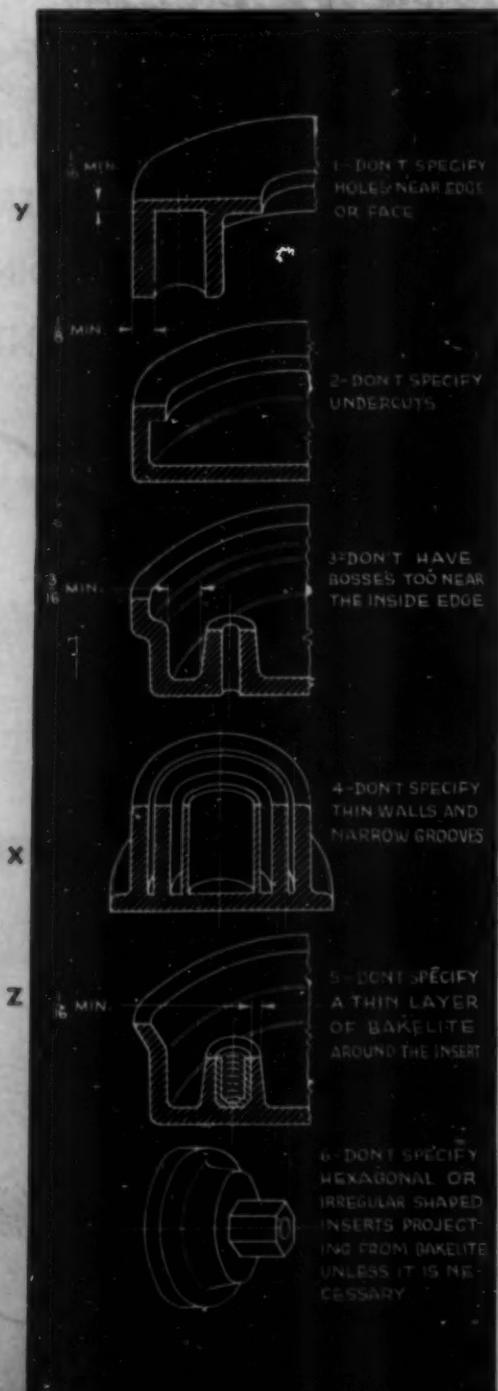
For obvious reasons, the yoke or cavity of the mold is usually mounted on the bed of the press. Thus the material placed in the mold must flow upward around the sides of the plunger when the pressure is applied. Therefore, thick sections should always be located as near as possible to the lower part of the yoke, to ensure these cavities being properly filled.

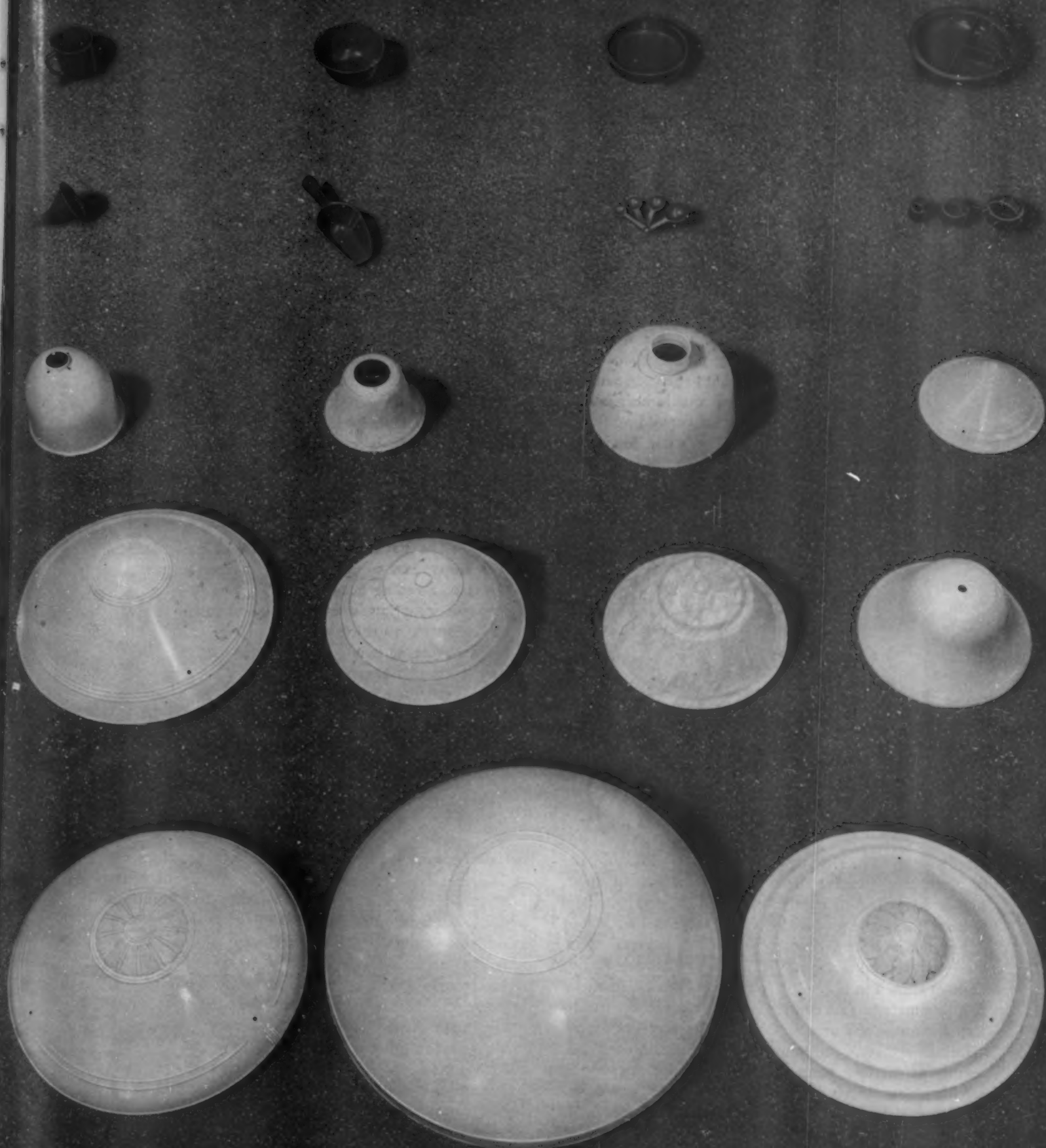
The thicker the wall section, the longer the curing time required, and naturally, the curing time for any piece will be that of its thickest section. For this reason, it is always best to keep wall thicknesses as uniform as possible, avoiding heavy, solid sections. Where extra strength or support is desired, it is best to use reinforcing ribs rather than a thick wall.

On the other hand, an extremely thin wall section may warp when removed from the mold, because it cools more rapidly than the rest of the piece. Lacking strength, it may also break or crack easily. Thus very thin walls should be avoided and by the same token holes should not be drilled or molded too close to the edge of the piece (see Figs. X and Y).

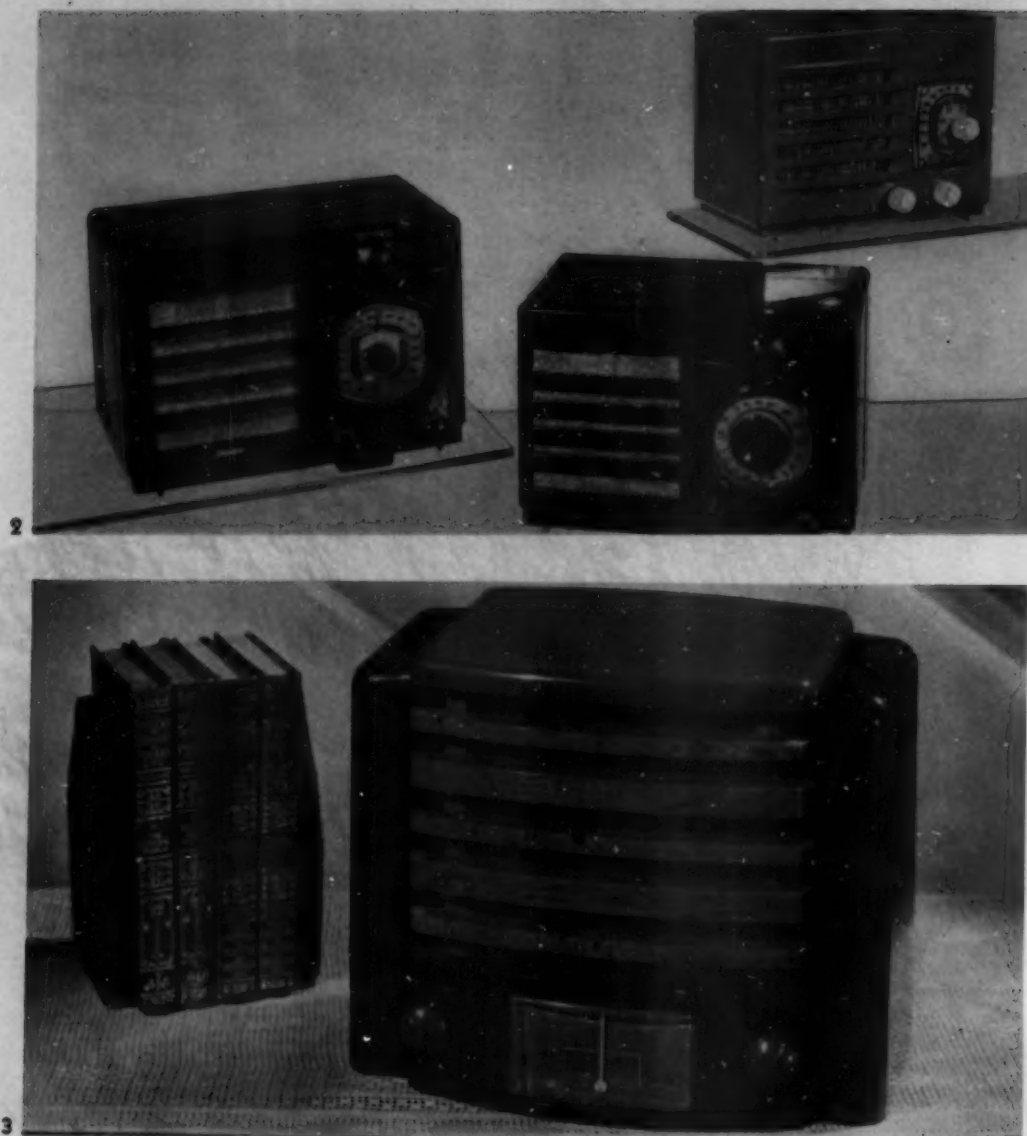
Since the plastic materials have about twice the shrinkage of metal, metal inserts should not be molded too close to the edge of the piece (see Fig. Z) since a very thin coating of material would crack upon cooling. Very large metal inserts should be heated to mold temperature in advance of molding, so that the material will form around them readily without requiring extra curing time. In the case of small metal inserts, the mold must be closed slowly so that the pressure will not break or bend the light metal.

One of the advantages of compression molding, especially from the sales standpoint, is that a wide variety of colors can be secured from the same mold. An interesting example of this is the Silvertone Radio cabinet illustrated in Fig. 1. The lowest priced model is produced with a cabinet of lustrous black phenolic material. With a cabinet of colored phenolic material, the





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(All photos courtesy Chicago Molded Products Corp.)

cabinet is sold at a slightly higher price; with a cabinet of ivory urea material the price is about fifty percent higher than that of the low-priced black model. All three styles can be produced from the same molds.

Another interesting instance in which color variety is used to lend sales appeal, is the International Radio Cabinet shown in Fig. 3. In this cabinet, three distinct molding materials are employed; the frame is of phenolics; the top is of a urea material; and the grilles are of cellulose acetate. Ingenious design permits easy assembly of the four parts of the cabinet, by the simple setting of four screws. As will be readily seen, an almost infinite variety of striking combinations in color and finish are obtainable from the one set of molds.

Changes in surface design can often be readily accomplished by means of loose plates, inserted in the mold. A radio manufacturer made three models, identical in size (Fig. 2). The same mold was employed for the cabinets of all three, but the face of each was given a different appearance by the use of an inserted plate.

Radio cabinets have been cited, of course, merely for

purposes of uniform illustration. These suggestions are at least equally applicable to a wide variety of other products, in which plastic materials, compression molded, can be used to great advantage, both from the standpoint of sales, and that of economical, high speed, quantity production.

The rules laid down, and the suggestions offered will be helpful to any engineer called upon to design a product in which plastics can be used to advantage. Anyone reading the foregoing explanations will realize, however, there are many details in every molding job which can be worked out only by a thoroughly experienced molding engineer. Almost without exception, therefore, the firms who are most successfully using molded plastics make it a practice to consult their custom molders, while their designs are still in the formative stage. Often, a skilled molding engineer can suggest a minor change or two, perhaps in some other part, which will improve the molded piece or make it more economical to produce.

A sound rule, therefore is: Always consult your molder before beginning the actual set up for production.

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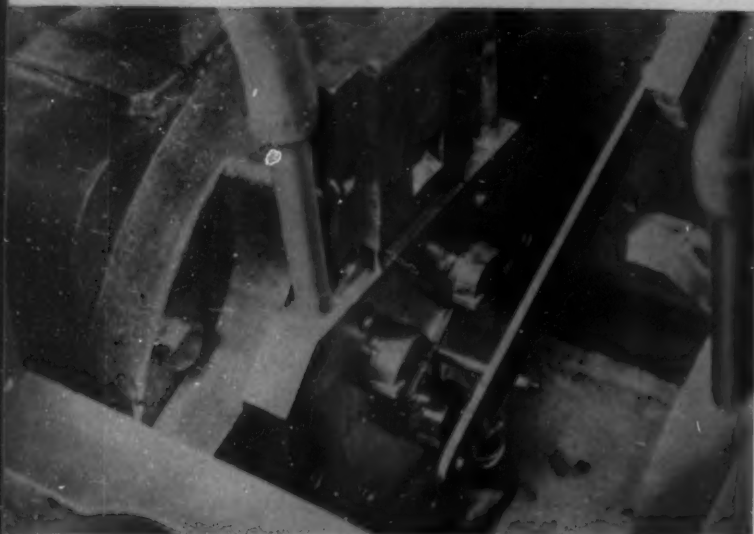


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NEW YORK





Radio knobs being ejected from the die of the Isoma machine

## INJECTION MOLDING

(Continued from page 138) closed and held under pressure against the nozzle, the ram *R* moves forward, forcing the cold material toward the nozzle and filling the cavities with melted material under pressure. The pressure holding the die closed and against the nozzle, and that used to inject the plastic material, are applied until the casting has chilled sufficiently when the injection ram retracts, the die opens and the solidified casting is ejected, usually by automatic means.

In actual practice, the die does not usually open as soon as the injection ram retracts but, instead, it is usually caused to pull a small distance away from the nozzle where it is held closed for an additional interval of time while the solidifying process is completed. Then the movable half of the die moves away from the "stationary" part to its extreme backward position, thus completing the cycle. The various operations described can be either manually or automatically controlled. In molding pieces without inserts, the machine is usually set for fully automatic timing and operation of the various steps in the cycle. When inserts are used, manual control may be employed, or the machine may be set to go through one cycle automatically and then stop, giving the operator whatever time (usually variable) is required to place the insert in the mold.

Ordinarily the die is kept cool by circulating water at the proper rate, depending upon the weight and thickness of section of the casting. Obviously, when a casting of large size is being injected, a one or two cavity die is used; but when the piece is small compared to the heating capacity of the machine, the number of cavities is increased proportionately, unless it is limited by some other consideration to a smaller number than the heating capacity dictates.

Thermoplastic materials differ from those of the thermosetting type in several respects. The most important, from a molding point of view, is that the former soften each time they are brought to the proper temperature (also affected by the pressure); while the latter,

once they are "set up," cannot be softened sufficiently to be molded again. In addition, a rather definite time is required for the "curing" of thermosetting materials. This "curing" time varies with the thickness of the piece, temperature used in molding, the degree of curing desired and, to a somewhat lesser degree, several other factors. But since a limit to the temperature is imposed by a tendency toward decomposition, the molding cycle ordinarily consumes an average of about three minutes. With injection molding of thermoplastic compounds, however, the usual molding cycle is perhaps 3 to 5 per minute. Therefore, for the same output, the latter requires roughly one-twelfth the number of cavities required by the former.

Assuming that a large output of pieces is required, it would seem that the injection process has considerable advantage, in the way of die cost. Actually this apparent advantage is considerably cut down by the higher cost of the die proper, without any consideration of the number of cavities, due to cost, in some cases, of sliding cores and automatic ejection means; and, in all cases, of sprue and runner channels. Therefore, since the cavities themselves (unless they are unduly complicated) contribute a relatively small part to the entire cost of an injection mold, it follows that, from the standpoint of die cost alone, where the output required is limited, a compression mold is cheaper. But where large quantities of pieces must be molded, the die-cost advantage is on the side of injection molding.

Another consideration both in die cost and in piece cost, is the size of the piece to be molded. If the piece is so large that a single-cavity die is all that the injection machine will handle, then it will be necessary to employ more than one die and one machine to give a reasonably large output, and in this case, both the die and molding costs may be less by pressure molding. Of course, this state of affairs exists only because at present the maximum capacity of presses of the conventional type greatly exceeds that of presses of the injection type. Whether the pressure-type press will maintain this lead is somewhat a matter of speculation.

A third factor affecting the relative piece costs of the two processes is the quantity of pieces required in a single run, or of a single color. Even if the piece is small, so that a multi-cavity injection die is indicated, still the piece price may be relatively high for a small number of pieces, because of the comparatively high set-up cost and, in the case of changing colors (unless the change is from a light color to a relatively dark one), because of the cost of cleaning the heating cylinder. Obviously, it is also uneconomical to decrease the number of cavities below the capacity of the machine and tie up the machine for a longer time.

There are several limitations to the maximum output of an injection molding machine, and whichever one gives the lowest maximum capacity will be the determining factor. To begin with, plastic materials have a high value of specific heat: that is, a large amount of heat is required to raise the temperature by a given amount. In addition, they are poor heat conductors,

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which means that heat passes slowly from the hot walls of the heating cylinder to the center of the mass of molding powder moving through it. Finally, such materials cannot be held for a long time at the injection temperature without causing decomposition of the plasticizer used to make them flow properly.

All this means that the heating cylinder must be designed to properly soften the maximum amount of material which the machine can handle, as determined by the available die-closing and ram pressures, and the length of time required for cooling the piece and for completing the rest of the cycle. In order to avoid the effects of poor heat conduction as much as possible, the path through the cylinder is often broken up into a number of smaller passages so as to increase the area of contact with the hot cylinder walls and decrease the thickness of the mass being heated.

Finally, when the amount of material being injected per hour is far below the maximum heating capacity of the cylinder, there is some tendency to burn, in spite of the use of automatic temperature controls; and it would seem desirable to divide the heating elements into a number of smaller ones, each capable of individual control, to provide the proper flexibility. This would allow heating the material for approximately the same length of time, no matter what its rate of flow through the cylinder may be.

Assuming a heating cylinder of a certain design and size, it is obvious that the maximum weight per piece (meaning the entire casting including sprue and runners, no matter how many cavities) must be considerably below the weight of material which the cylinder will hold, for the reason that all of it is not properly softened—that

in contact with the ram being relatively cold powder (actually granules) and only that portion near the front end of the cylinder being of proper injection consistency. This is, therefore, the first limitation to output.

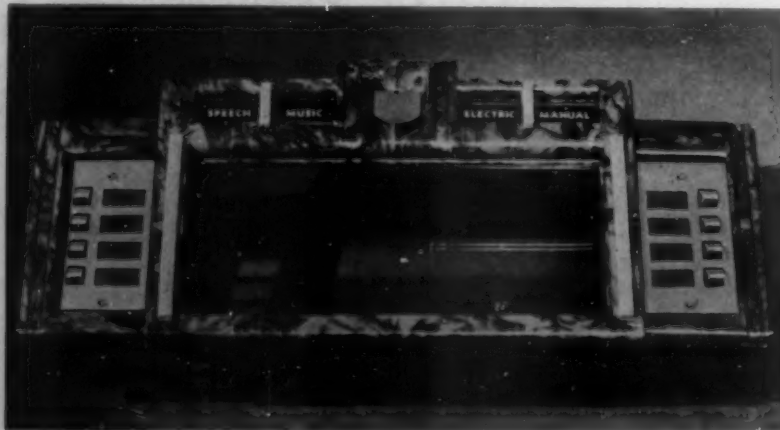
Next, the projected area of the piece must be considered. This is the total area in the plane at right angles to the axis of the ram. It is plain that as the injected material spreads out and fills the die cavities, the pressure tending to force the two halves of the die apart is equal to the injection pressure multiplied by the ratio of the projected cavity area to the area of the end of the ram. Actually, the injection pressure is not increased by as much as the above ratio, because of the frictional loss in pressure as the material flows into the cavities. Nevertheless, if the projected area of the molded piece is too great, the die will be forced apart, resulting in flash.

Even if the projected area is not too great for the die-closing pressure available and if the piece weight is not too great an *instantaneous* demand on the heating cylinder, we are still limited in the number of pieces that we can mold per hour by the maximum *continuous* heating rate of which the cylinder is capable. This is the third limitation.

Then, if the limiting conditions above are all satisfied, but if the piece is long and thin and the plastic material must flow from one end of such a section to the other along its length, as in a grille, trouble may be experienced due to partial cooling before the cavity is filled. This may be overcome to some extent by running the die warm; but it can be done only to a limited extent because the cooling time is correspondingly increased.

Finally, if the cast piece has sections which are too

Radio dial and bezels injection molded with the glass an integral part by Erie Resistor Corp. Lower right—Fuse holders of Lucite which replaced glass for these parts



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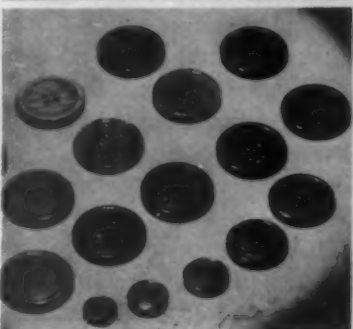
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Counters

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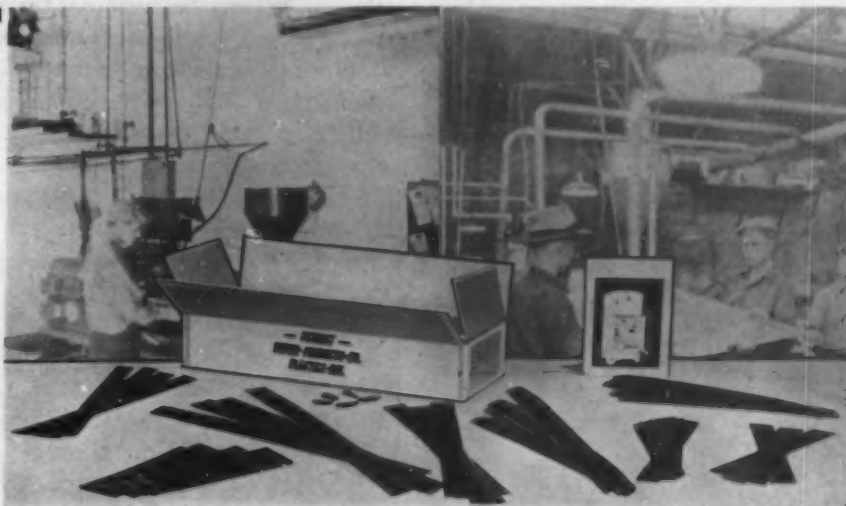
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thick, undue shrinkage will result. This can sometimes be avoided by hollowing or coring out such sections. In addition, a thick section adjacent to a thin one will cause unequal shrinkage unless the die can be designed to feed into the thickest section. For best results, the piece to be molded should be designed with as nearly constant wall thickness as possible.

There are, of course, other more minor difficulties experienced in injection molding, but these are outside the scope of this article. One important consideration is

the size of sprues, runners, and gates; but these depend upon so many complicated factors that no hard-and-fast rule can be laid down.

Injection molding materials are available in a great variety of colors and degrees of hardness; in transparent, translucent, and opaque of various degrees; and in plain or variegated color combinations. On account of its thermoplastic character, scrap material may be reground and a limited percentage mixed with virgin material of the same color to be molded again. Excess scrap may, of course, be dyed black.

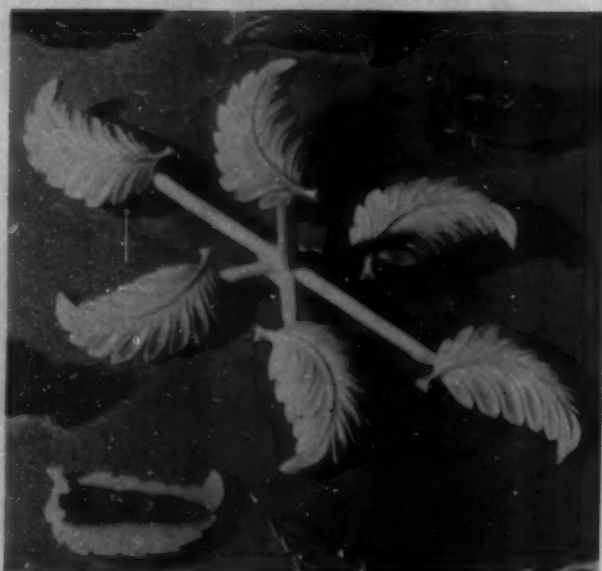
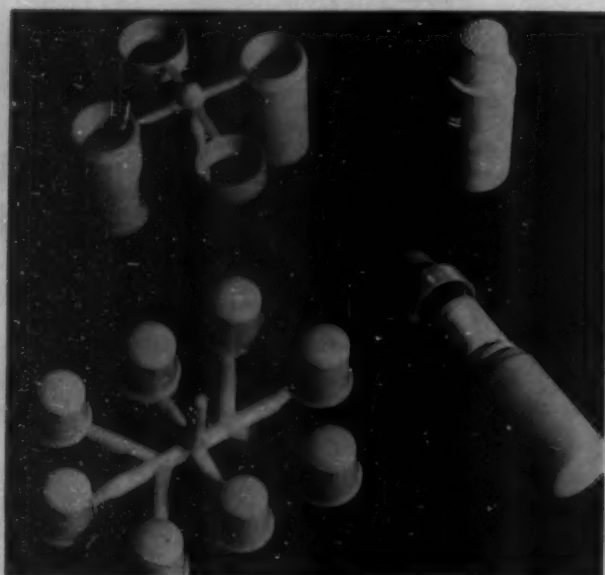
The finish is usually good enough to require no buffing after molding and, except for certain difficult pieces, little or no flash is present. Gates can be made thin enough that, when broken from the casting, the gate fin is easily removed.

A large percentage of pieces molded are without inserts, though injection molding lends itself to their use because of the fact that the material is relatively fluid when it enters the cavity and therefore tends less to move or distort inserts, pins, and cores, than does pressure molding. We successfully mold complicated pieces such as sliders for hookless fasteners, and other cored parts, using not only end cores, but one or more sets of side cores pulled at different angles—often impossible with compression molding.

We also have developed a process for injection molding thermoplastics around the edges of glass sheets. These are being rather widely used as bezels for radio receivers. In cooling, the plastic material contracts and holds the glass firmly, so that rattling is prevented—one of the difficulties experienced with metal bezels. These units are molded either so that the sprues can be used as fastening projections, or with tapped metal inserts, holes tapped in the plastic, or with cored bosses which may be tapped after molding.

To date, the largest bezel molded by us has a rectangle of glass 6 by 6 $\frac{1}{4}$  in. (37.5 sq. in.), and a projected area of plastic around the glass of 28 sq. in. which also weighs approximately 90 grams. In addition, metal cores are successfully covered with plastic material, increasing the strength where required, and decreasing the cost over that of a solid plastic piece. In addition, shrinkage due to heavy molded sections, is eliminated, as explained above.

While this article is directed toward the injection process alone, it is not our intention to convey the impression that all the advantages are on the side of that method of molding. While there are some pieces which can be molded with equal success either way, in general each type of molding has its own field in which it is best suited to produce various articles.



Top—Sewing kits injection molded of Tenite by Thomas Mason & Co. Center—Costume jewelry of Tenite by Tilton-Cook Co. Bottom—Toys of Lumarith injection molded for the Kilgore Mfg. Co.

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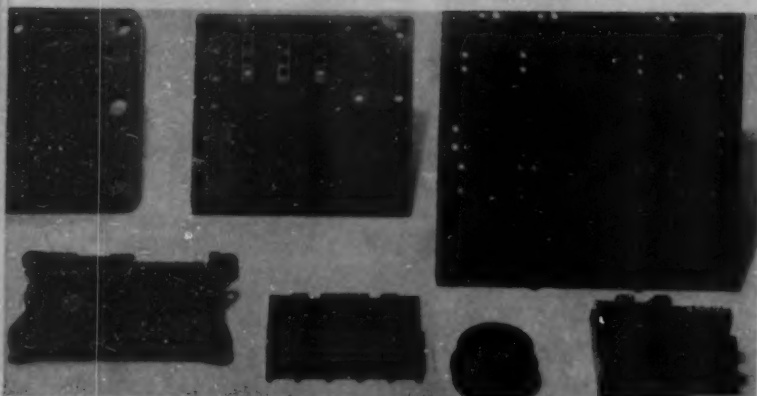
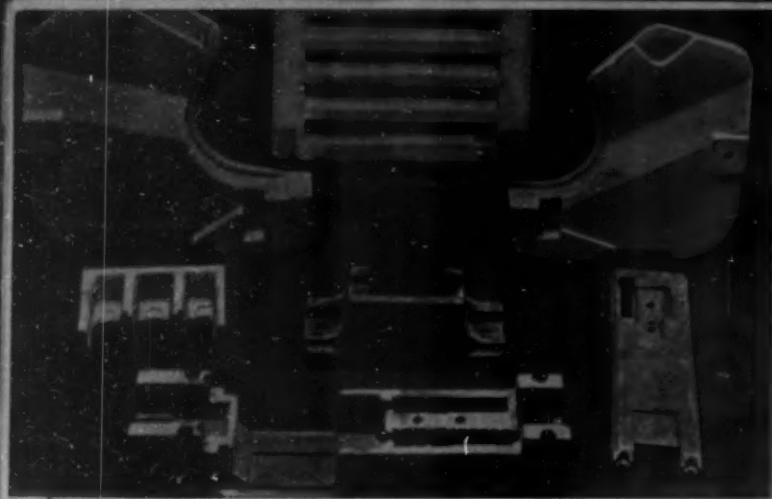


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3. Cold molded refractory parts for switch bases and arc shutes for resistance to high arcing and heat—as received from the mold. 4. Typical non-refractory parts available in a black or brown finish. (Both photos courtesy General Electric Co.) 5. Handles cold molded of a heat-resisting plastic especially adapted for this purpose. (Photo courtesy Cutler-Hammer, Inc.)

## COLD MOLDING

(Continued from page 142) pend largely on the design and shape of the piece to be molded. A competent engineering staff, thoroughly acquainted with cold molding problems can judge the shrinkage, after studying the part, and they can allow for this shrinkage in the making of the mold. Considerable progress has been made in the past few years in determining the shrinkage of certain wall-thicknesses and cross-sections. This has resulted in a higher degree of accuracy of moldings and allows snug assembly of two or more parts. This is well illustrated in Fig. 1 which shows three molded parts and how they appear assembled.

Unfortunately, perhaps, cold molded plastics lack fine appearance. However, their use is usually for parts that are hidden in the assembly of a product and consequently do not require a smooth lustrous finish. There is seldom a case where both resistance to heat or arcing and also good appearance are required in the same piece. There are a few ways of improving the looks of cold mold—as by tumbling with waxed pegs or buffing; but even then the result cannot compare with the finish of a hot mold.

Manufacturers often require a refractory material for resisting excessive heat or arcing but for various reasons object to the white cement color. This objection has been overcome by impregnating with a black dye solution. The penetrating method is superior from the standpoint of marring or chipping—the penetration is deep enough to avoid any white scars should the part be accidentally chipped or deeply scratched. Also, a surface treatment of the refractory material consisting of a dip in mineral wax tends to reduce the moisture absorption from approximately 12 percent to 0.50 percent. This is a valuable characteristic when the cold molded insulator is to be exposed to humid atmospheres.

## Properties

The chart at the bottom of the page gives, in general, the physical and electrical properties of the two types of cold mold—refractory and non-refractory.

There is a very definite niche in the plastics industry for cold mold products. A manufacturer who has a clear understanding of the advantages and disadvantages of cold mold and who through the help of the cold molder can properly apply cold molded plastics to his product will find economies and dependable product protection.

GENERAL PROPERTIES OF COLD MOLDED PLASTICS

| GRADE NO.          | COLOR AND FINISH     | WATER ABSORPTION<br>(Percent) (48 hr.) | HEAT RESISTANCE<br>(Deg. C.)<br>(Approx. temperature<br>up to which not<br>affected physically) | COMPRESSIVE STRENGTH<br>(Lb. per sq. in.) | TRANSVERSE STRENGTH<br>(Modulus of rupture)<br>(Lb. per sq. in.) | IMPACT RESISTANCE<br>(Charpy)<br>(Ft. lb.)<br>(Unnotched specimen) | DIELECTRIC STRENGTH<br>(Volts per mil)<br>(100 deg. C. in air.<br>Step-by-step test;<br>0.25 in. thickness) | DENSITY<br>(Lb. per cu. in.) |
|--------------------|----------------------|--|---|---|--|--|---|------------------------------|
| Non-Refractory     | Black,<br>Brown—Dull | 1.5                                    | 250   | 12,000                                    | 3,300  | 0.40   | 60  | 0.072                        |
| Non-Refractory     | Black—Dull           | 2.0                                    | 250   | 17,000                                    | 7,500  | 0.40   | 60  | 0.072                        |
| Refractory         | Gray—Dull            | 12.0                                   | 700   | 16,500                                    | 6,000  | 0.40   | 40  | 0.079                        |
| Refractory Treated | Black—Dull           | 0.50                                   | †   | 16,500                                    | 6,000  | 0.40   | 50  | 0.079                        |

† Tests incomplete

You'll Breathe Easier, too  
after using



*Stokes*

## MOLDED PLASTICS

Figuratively speaking, of course, unless you have hay fever. For the device shown is the "BREATHE-EASY," made for hay fever sufferers, molded of Tenite for the Breathe Easy Corp.

With 40 years of molding experience for our designers and engineers to draw upon, we want you to submit anything from a bare idea to complete blueprints and learn why production men find relief by placing their full confidence in Stokes molding services.

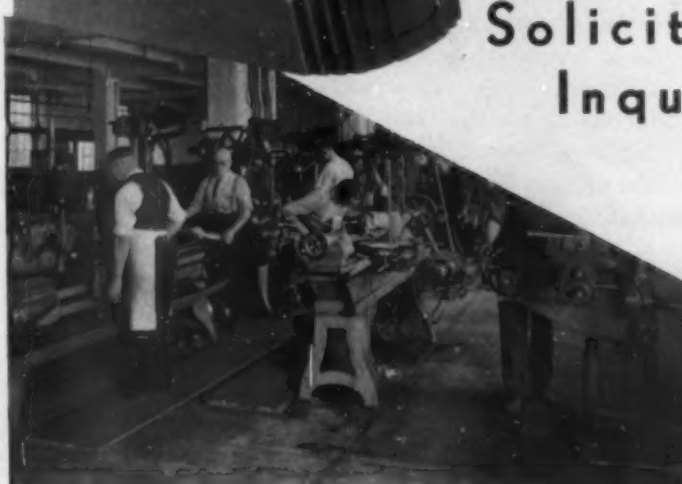


Reg. U. S. Pat. Off.

*Stokes*  
RUBBER CO.

322 WEBSTER ST., TRENTON, N. J.  
CANADIAN PLANT, WELLAND, ONT.

MOLDERS  
SINCE  
1897



A section of our tool and mold department

For Accurate  
and Quality  
Moldings We  
Solicit Your  
Inquiries



A section of our press department

B. F. OSHEI, INC.  
BUFFALO N. Y.

## CARE NECESSARY IN COLOR MOLDING

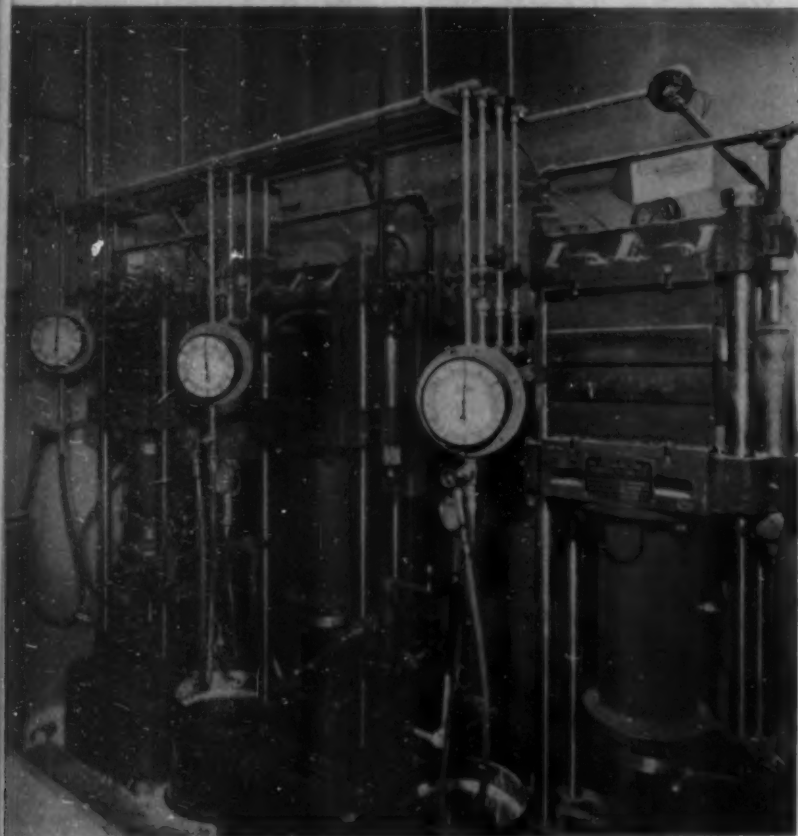
(Continued from page 144) sealed cans or drums, and are transferred to the press room, ready for the molding operation. The briquettes should be kept covered at all times until molded.

The ideal set-up for the actual molding of light colored materials is of course a separate room for each press, or completely enclosed section of the plant. The total volume of urea materials (in relation to all other types of compounds) does not as yet, however, justify such a utopian set-up in most molding plants. But further, because in most plants presses are grouped together by capacity, it is the rule rather than the exception to find a light colored urea material and a black phenolic being molded in adjoining presses. Hence it is necessary to shroud the "urea press" from the back and sides, either temporarily or semi-permanently, to keep flash and flying particles of the other material from settling on the preforms or in the cavities of the mold. Air currents are continually swirling in a molding plant because of the almost continuous release of compressed air in blowing finished pieces and flash from the molds.

When preforms are not used in molding ureas, the weighing out is usually done at the bench exposing the material to a still further source of contamination. Frequently a fixture is set up on the bench, which will



Experimental preforming plant at Plaskon Inc. also located in an air-conditioned room free from dirt



A battery of molding presses in the Plaskon plant used for experimental and control work operate under perfect conditions of cleanliness in an air-conditioned room

support an entire drum of compound in an inverted position, and dispenses material without allowing foreign matter to enter the drum itself. Or the material may be dumped from the drum into a large wooden box at the bench. The box has a removable lid to permit filling, but the material is removed as needed through a door in the side, hinged at the top, so dirt may not fall into it.

Air filtering of an entire section of a plant, in which ureas only are molded, or even of a single room in which large pieces are being molded, eliminates the greatest danger of contamination, and will undoubtedly come into increasing favor as the industry grows. Through the use of a blower, which introduces air through filters, the room is kept free of dirt, and a pressure is set up so that air passes from the *inside* to the outside when the door is opened. This removal of contamination from the air plus the absence of other colored materials from the immediate premises, practically ensures clean moldings.

As the consumption of urea compounds has increased, every custom molder has given more and more thought and engineering talent to ways and means of producing spotless pieces. That there is vast room still for improvement is unquestionable; but even so, and considering that many of the molders are still operating in shops originally set up to handle only dark colors in which the dirt factor is practically negligible, no manufacturer need fear to order light colored, translucent pieces, nor expect to receive anything but highest quality production.

# The Economical Stamping Medium for **PLASTICS**



Suitable for stamping all manner of lettering, decorations, numbers, trade marks, etc., on practically all plastic materials.

Practical and ECONOMICAL! Used and endorsed by leading industrialists. Samples and full details promptly upon request. Write direct or to our nearest representative.

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50 E. 21st St., NEW YORK    536 So. Clark St., CHICAGO  
Marshall Son & Wheelock, Inc., 228 Purchase St., BOSTON

## BRIGHTEN LEAF

*"Stamps Every Job a Good Job"*

INSTRUMENT PANEL  
of  
PHENOLIC RESIN

SIDE WALL TRIM  
MOLDING OF  
CELLULOSE ACETATE

UREA  
LAMP SHADE

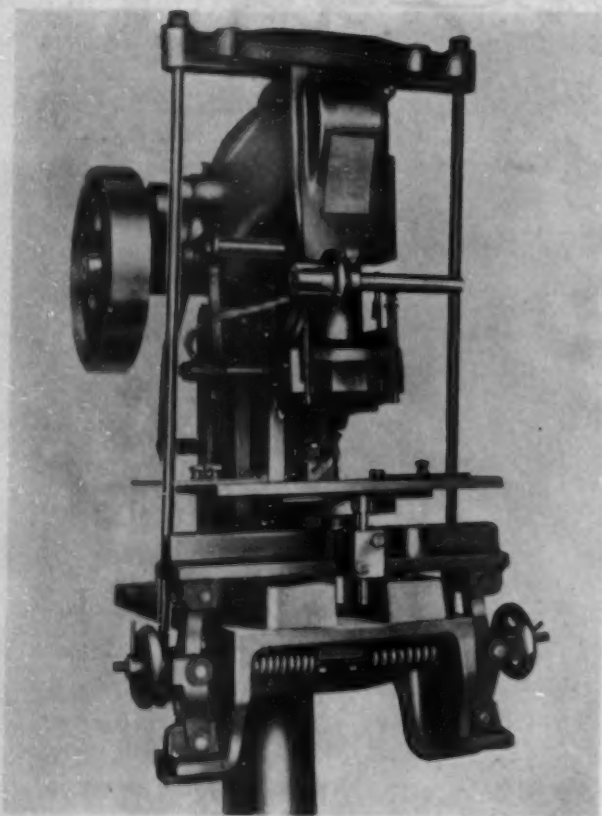
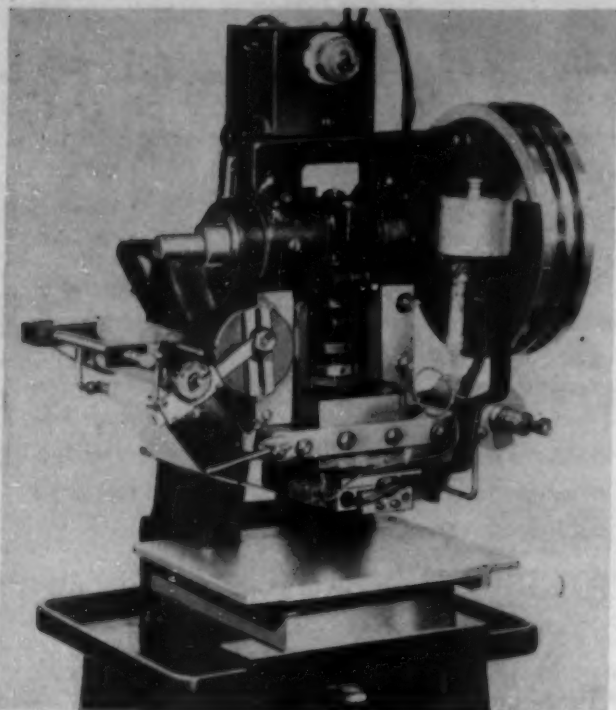
MOLDED  
THIKOL  
PARTS

UREA TWIN  
SALT AND  
PEPPER  
SHAKER

Molders of Rubber, Synthetic Rubber  
Thermo setting and Thermo Plastic materials

Our complete laboratory and Factory facilities  
are at your service.

**WARD PLASTIC & RUBBER CO.**  
1037 HILTON ROAD,    FERNDALE, MICHIGAN



Top photo illustrates a plain power stamping machine for roll leaf. (Photo courtesy Griffin, Campbell, Hayes, Walsh, Inc.) Lower illustration is a power stamping press with toggle supported bed, adjustable to variations in thickness up to  $\frac{1}{4}$  inch. Suitable for high speed stamping on plastic products. (Photo courtesy Peerless Roll Leaf Co., Inc.)

## PRINTING ON PLASTICS

(Continued from page 146) various mechanical handling and compensating devices which take care of any ununiformity in thickness and shape of the article being stamped. A single web of roll leaf, or even two, three and four webs, can be used simultaneously on a press.

Flat stamping may be done with brass or steel type, but for intricate designs, signatures and decoration, hand-cut brass or steel dies are required. Brass is usually sufficiently strong for use with acetates and other thermoplastics, but where phenolics and ureas—thermosetting materials—are used, the strength of hardened steel is demanded either in type or dies. A combination stamping and embossing die may be used on thermoplastics, but is not practical for articles made of thermosetting materials. Dies are usually attached to the press by screws or by gluing to the die plate if they are not more than  $\frac{1}{4}$  in. high. Dies that are type high or actual type may be locked in a special chase. Cutting letters or intricate designs in molds, then wiping in contrasting colors in the resulting molded parts is an expensive procedure. This is entirely eliminated by using roll leaf. It costs one-third as much to do a stamping job as a wipe job, since the latter must be finished, polished, wiped off and cannot be shipped until it is dry. Employing roll leaf an item may be stamped, packed and shipped with no time lost in waiting for the lettering to dry.

This type of stamping originated when manufacturers of radio tubes found that using the plain burnt process did not show up on the dark bases, and that if color contrasts were available, more suitable and more easily identified markings would result.

Dressware also benefits by this method of decoration. Formerly toilet sets had been made of enamel inlaid with genuine gold, which was naturally costly. Then pyroxylin articles were manufactured and gold leaf stamped on. A pleasing decorative effect is achieved and such sets are available at a nominal price. This method of decoration can be applied to either cast or molded jewelry, where metallic or pigment coloring can be impressed without the necessity of employing inlay.

Glass signs used for advertising and display purposes are usually hand painted, taking one man about two hours to produce one sign. Transparent plastics, however, stamped with roll leaf can be reproduced at the rate of thirty a minute.

The cost of roll leaf printing equipment is not excessive and molders or manufacturers with continued production of small parts which must be marked or decorated will find them practical to operate in their own plants.

### Printing in colors

For those who want color, anigraphing has been developed for just that, permitting any copy to be printed in four colors in a single operation. Half tones and line drawings are accurately reproduced and printing is done directly on containers or other plastic parts. Paper

(Continued on page 190)



*Plastic products which have been marked for lifetime identification with Peerless Roll Leaf.*

## LIFETIME IDENTIFICATION

*For All Types of Plastic Products*

The ideal method of trademarking plastic products is to stamp them with Peerless Roll Leaf on a Peerless Stamping Press.

It is a simple process. A roll of Peerless Leaf is fed automatically across the heated die. A single press operation engraves the trademark or design into the surface of the plastic, transferring the roll leaf at the same time. The result is a clean cut impression in gold bronze, silver, or colors, an impression which will last as long as the product itself.

We invite fabricators, molders and users of plastics to investigate the Peerless method. Send us, if possible, a sample of the plastic items which you mark or decorate. We will stamp them with Peerless Roll Leaf and return them to you for your examination. Write to PEERLESS ROLL LEAF CO. INC., 917 New York Avenue, Union City, N. J.



*A Peerless Power Stamping Press designed for stamping small plastic items with Peerless Roll Leaf at the rate of approximately 75 to 90 per minute.*

**PEERLESS ROLL LEAF CO., INC.**

917 New York Ave., UNION CITY, N. J.

*Branches in Boston and Chicago*



## NO SIMPLE JOB—

this housing for a hand-manipulated Sun Ray Lamp—which taxed the ingenuity of the die maker and skill of the moulder.

Yet these two pieces are moulded so accurately that each half meets its mate in perfect alignment. It's a marvel of die making and moulding, accomplished entirely in the K & J plant.

Here, also, is what occurs when design and engineering join forces to produce an attractive moulding, perfectly fitted for its job.

If you are wondering whether or not moulded plastics will fit into your manufacturing scheme—or are now planning a step in that direction—Kuhn & Jacob have the facilities to do the job from design straight through to production.

**Kuhn & Jacob**  
**MOULDING and TOOL CO.**

1202 Southard St., Trenton, N. J.

New York Office, PENN 6-0346

Phila. Office, HANcock 0972

## PRINTING ON PLASTICS

(Continued from page 188) labels do not properly adhere at all times to the smooth hard surfaces of plastics and this method of direct printing assures copy staying on the package for some time.

Articles to be printed are automatically fed from a hopper and when the printing process is completed, are ejected at the rate of forty to sixty a minute and are conducted by automatic traveling conveyors to an oven where the articles are subjected to electrically controlled heat for thirty minutes. This results in the printing becoming an integral part of the container. It resists the action of moderate solvents and also the wear and tear which frequently defaces paper labels. The heat of the oven is carefully regulated and no shrinkage, distortion or discoloring of the plastics takes place. Printing is done with a slightly rolling motion of the container or part to ensure even distribution of ink.

Plastic containers are making rapid inroads into practically all fields where manufacturers are conscious of the importance of improved and modernized product containers. And this method of duplicating the appearance of labels, utilizes new decorative possibilities and offers an added functional element in plastics packaging. Containers may be printed in an all-over pattern or with a single line of copy, and closures are similarly treated.

## Engraving

Retail stores frequently want to individualize customer purchases, mark samples for identification or do small decorative jobs, so marking devices for plastic products have recently been created for this work. Marking is done by cutting the letters or designs (approximately .005 in. deep) with a rotating cutter, driven by a small motor. The lettering or design is filled with gold, silver, white paste or lacquer, furnishing a color contrast to the material engraved, and the whole procedure takes but two or three minutes in all.

Wherever it is desired to reproduce printed characters, brass type, much like printer's type, is set up in a special holder where they can be traced with a tracing point.

The machine is not limited in its use to Arabic characters, but by reproducing from printed or drawn originals on paper, Chinese, Japanese, and similar letters, signatures, and alphabets can be cut. This is of particular value for goods being exported.

If an exact reproduction is not required a penciled line on a paper sheet is used as a guide, such as reproducing a signature on a fountain pen. The operator merely traces along the lines of this signature and if he should fail to follow them exactly there will be no apparent difference because the cutting is reduced in size to about one-half the original sketch. A master of transparent pyroxylin which has a sunken line cut just deep enough to permit the tracing point to follow in the line without slipping away can be used when a number of pieces are to be identically engraved. These machines will engrave objects of any shape and, being hand operated, are not costly to install in either a plant or retail store.

## MOLDING WITH RESIN BLANKS

(Continued from page 148) of impact resistant materials, including the production of molding boards and blanks. The latter are cut or punched from molding board which is made by combining phenolic resin and fibers on paper making equipment.

Molding board together with the improved shock resistant molding materials now fills the gap between molding materials and laminated products. It not only meets this requirement but it has found its place in conjunction with both of these previously known and widely used materials. This board is produced in sheet form from .031 in. to .141 in. in finished molded thicknesses. The resin is incorporated in the sheet during the manufacturing process and for all intent and purposes, the board as supplied to the fabricator, is similar in composition to the molding material, with the physical characteristics of the laminated product.

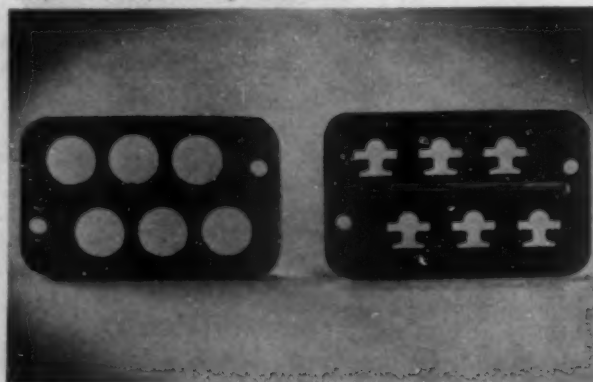
In sheet form molding board is employed for strips, such as refrigerator breaker strips, for table tops, trays, machete handles and many such semi-formed pieces.

Many interesting applications of molding blanks which have been punched or cut out of the sheet and molded into a finished item have been found. They have proved particularly advantageous where it was necessary to have greater shock resistance than could be obtained with the regular molding materials. One instance of this is a mounting base (Fig. 2) which has to have enough shock resistance to withstand riveting in an eyelet machine. It is also required to have several holes and a rib down the center about  $\frac{1}{4}$  in. in height. Blanks are cut from the board and with the addition of a small amount of molding material, the parts are molded in exactly the same way as though a molding material only had been used. These parts withstand the assembly operation of automatic eyelet machines with ease.

These new molding blanks can, under proper conditions, be made to form intricate pieces. Boxes with a side wall flow of three to four inches have been molded from flat shapes placed in the bottom of the mold. This type of molding with long flow is not desirable as it is not advisable to attempt to use molding board on castings which require a long flow. A stronger product can be produced with a shock-resistant molding material.

(Continued on page 192)

Fig. 2. Insulating part used by Minneapolis Honeywell Regulator Co.



# PLASTIC MOLDS

Since 1918 leading molders have recognized this firm as the outstanding specialists in the manufacturing of molds for plastic materials, in die-sinking, engraving and hydraulic hobbing.

Our plant is Keller, Gorton & Blanchard equipped for the most economical and speedy production of superior molds.

Place your problems in the hands of this experienced, well recognized and financially responsible concern.



**NEWARK DIE  
COMPANY, Inc.**

24 SCOTT STREET, NEWARK, N. J.  
TELEPHONE MARKET 2-3772-73



**WHAT'S THE DIFFERENCE  
BETWEEN ONE MOLDER  
AND ANOTHER?**

Typical of P.M.C. engineering skill is this shade designed, engineered and molded by Plastic Molding Corporation for the Chase Brass Corporation.

There are many good molders. And the purchaser of molded parts or products may logically ask whether it makes any difference who does the molding. For your guidance, here are some outstanding facts about the Plastic Molding Corporation.

**P.M.C.** engineers have 18 years of direct molding experience behind them.

**P.M.C.** owns a completely integrated plant . . . able to perform every molding and mold-planning operation under a single roof and a single control.

**P.M.C.** can refer you to half a gross of clients—in almost every line of industry—who have found its prices right, its molding perfect, its inspections rigorous and its promises performed or exceeded.

*We invite your further inquiries*

**PLASTIC MOLDING CORPORATION**  
SANDY HOOK, CONNECTICUT

SINCE 1918

# PLASTIC MOLDS

**HAND  
AUTOMATIC  
SEMI-AUTOMATIC  
and EXTRUSION  
to the  
LATEST METHODS**

Designers and builders of all types of PLASTIC MOLDS.

Serving most of the leading molders in the country!

Our 1500-ton hydraulic Hobbing Press adds many advantages in obtaining lower mold costs.

Estimates on request.



**EAGLE**  
**TOOL & MACHINE CO.**

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Phone: MARKET 3-1572  
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## Quality Molders

with the ability and experience needed for finer and more exacting work in molding parts or products.

Call upon Niagara engineers for aid or advice in planning your moldings.

**NIAGARA INSUL-BAKE  
SPECIALTY COMPANY, Inc.**

483-483 Delaware Ave. Albany, N. Y.

Fig. 3. Small dome shaped punchings of molding boards are employed to reinforce the mounting lugs of this control switch made by The Felt and Tarrant Co.

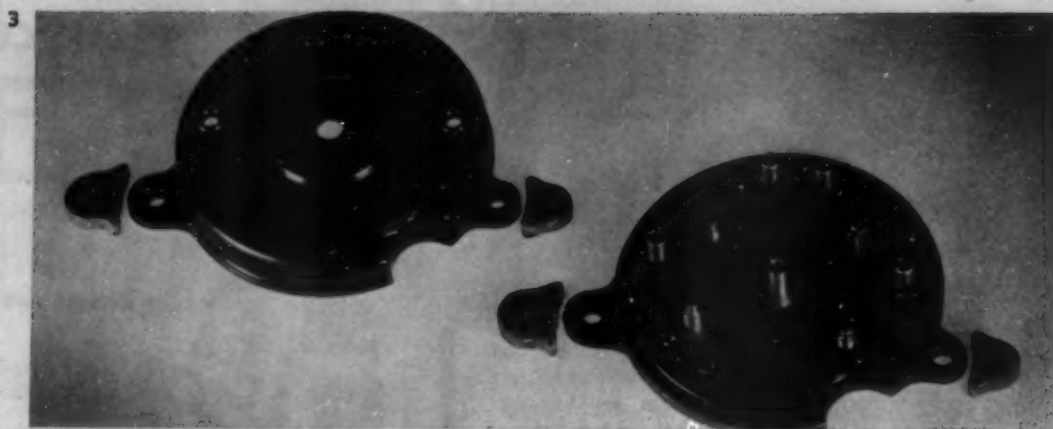


Fig. 4. A combination of shock resistant molding material and a reinforcing ring of molding board for the lip of the flanged edge has eliminated breakage on this orange juice extractor made by Hamilton Beach Manufacturing Co.



(Continued from page 190)

In a great many cases molded parts need to be reinforced at one or more crucial points, and this is where blanks are particularly useful. Reinforcing is readily accomplished by the proper use of a punching or blank placed in the mold at the point to be reinforced. The molding material, either loose or preformed, is loaded together with the blank. Molding of parts like this is easily accomplished because the curing time and general composition of the molding material and blank are approximately the same.

A housing for the control switch on a Comptometer (Fig. 3) had nine inserts, a recessed side and two lugs for attaching the molded cover. The tolerance was limited, due to the compact assembly, and the mounting lugs could not be made very heavy. Experience proved that some of these lugs were broken off in shipping and use. Molding blanks were resorted to and a small dome shaped punching was placed in the mold so that during the molding operation the lug was formed of the tougher board, which welded into and became an integral part of the main casting. By applying this same principle to the lugs on both the base and cover, breakage was eliminated and a very satisfactory product was produced.

Another type of reinforcement was necessary on an orange juice extractor funnel (Fig. 4). During the course of a day's work in satisfying the public's demand for orange juice, it was found that occasionally the pulp from the oranges gathered on the shoulder of the funnel

and in time built up so that all the pressure exerted by the operator was on the side of the molded casting. Therefore occasionally one of these funnels would break. After some investigation it was proved that by using a shock-resistant molding material and ring cut from molding board much greater strength would be obtained. This ring is so cut that it will reinforce the shoulder and at the same time will give added strength around the lip of the flanged edge about  $\frac{1}{8}$  in. down the funnel. As a result of this construction another job has been made safe for plastics.

At least one piece is being produced with a molding blank center and molding material side wall. After molding, several holes are punched through the center part in the same manner as though a piece of laminated stock were being punched.

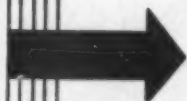
There are many other applications of reinforcing jobs being made with a combination of molding board and molding material. There are also applications where the board can be used in molding parts without the use of molding material. It should be feasible in the future to make kettle handles using two strips of molding board around the metal prongs that attach to the utensil. This method of construction would permit a much thinner handle and one that would stand a surprising amount of abuse. This may give some indication of the future possibilities for this new "baby" of the plastics industry which has been developed to bridge the gap between molded and laminated products.

Another  
**"ACCURATE"**  
 molding!



Your products can profitably enjoy the benefits of ACCURATE experience in planning plastic products for economy or production and salability. We are fully equipped to design, make molds and produce the highest type of plastic products and parts.

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 120 Nassau St., Brooklyn, N. Y.



**SAVE TIME....**

### Make a Practical Model First

WE have saved significant sums for many plastic users by first making a demonstration model. Many people are handicapped by a drawing as they cannot pick it up, look it over or admire it. With a model you can do all these things and a difficult process of visualizing is not necessary. We make models of Bakelite, Catalin, Celluloid, Lucite, Tenite, Lumarith, Wood, Fibre or in any kind of material.

Displays and other few-of-a-kind products made to order.

Hobbs and single cavity experimental molds for all plastic materials. Development work of all kinds.

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MECHANICAL DEVELOPERS  
 19 West 24th St., New York - WAtkins 9-0191-2



## The Clean Buffing Compound

LEAROK has no "free grease" in it. It is clean. It doesn't get into crevices and ornamentalations. This, coupled with its excellent buffing properties, make it ideal for finishing plastics. LEAROK can be obtained tinted to match the color of the finished article.

Send a sample of your work for our recommendations.

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 636 Notre Dame St. West, Montreal, Canada

**WE CAN DO YOUR  
 "EASY JOB"  
 BETTER BECAUSE...**

we've done so many tough jobs before. Attleboro engineers know how to design molds for that extra ten percent production that spells high speeds and low costs... they know the tricks of the trade that can be learned only through years and years of experience... they know how to eliminate troubles before they occur.

The Engineering skill that has brought to our doors many of the toughest jobs in the molding field—giant housing, intricate inserts, close tolerances—this skill can help us do your job better, faster, and at lower cost.

**ASSOCIATED ATTLEBORO MANUFACTURERS, INC.**  
 ATTLEBORO. MASSACHUSETTS

## FABRICATING CAST RESINS

(Continued from page 150)

Ordinarily cast resin materials are delivered to the fabricator in standard shapes such as round rods which may be from 12 in. to 20 in. long and  $\frac{3}{8}$  in. to 6 in. in diameter; tubes, varying in size from 6 in. to 8 in. in length and 1 in. to 8 in. in diameter; sheets that are approximately 6 in. by 16 in. up to special sizes as large as 10 in. by 20 in., in thicknesses from  $\frac{3}{16}$  in. to 1 in.; and blocks that range from  $\frac{3}{8}$  in. square to 4 in. square. This list of stock shapes is constantly being augmented to include such items as handles for cutlery, kitchen

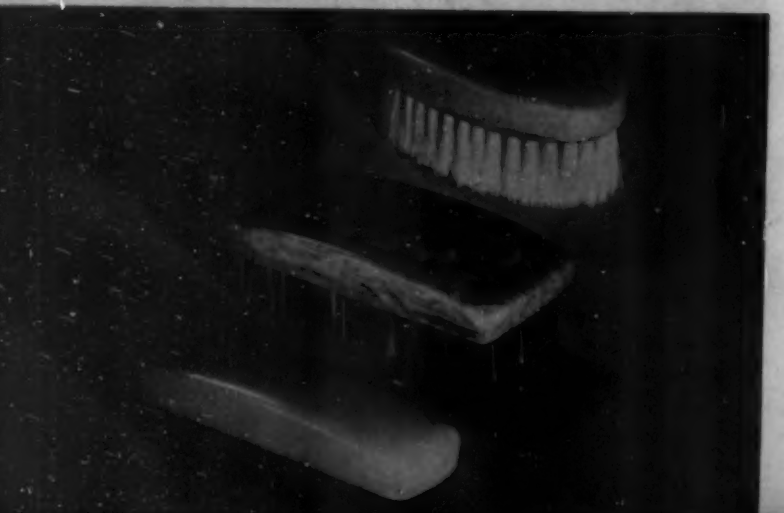
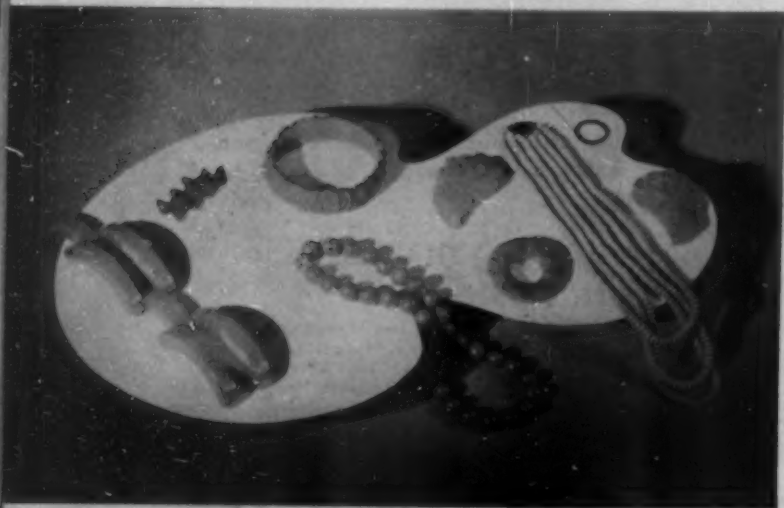
implements and razors; cigaret lighters, gear shift knobs, fender guides, etc., for automobiles; clock cases; lamp parts, etc. In addition, special castings are prepared to the customer's specifications, for since these resins are cast in lead molds, which are comparatively inexpensive, it is possible to approximate any desired shape which is required in quantity.

However, a surprising number of widely diversified articles can be fashioned from standard stock shapes. For example, cast resins have become increasingly important in the chemical field for the production of transparent retorts, funnels and beakers used in laboratories. Naturally, materials used for this purpose must be both unbreakable and resistant to chemicals coming in contact with them, and cast resin is endowed with both these properties. Incidentally, it is the only material, with the exception of lead, which is suitable for storing or working with hydrofluoric acid, and lead, of course, has the disadvantage of being non-transparent. Chemical funnels and beakers are turned from solid rods supplied as standard shapes. If a 2 inch measuring beaker is required, let us say, the long rod of cast resin is sawed into lengths of this size. Then each short rod is placed in a lathe, hollowed out in the center, and shaped to the desired contour including a pouring lip at the top. The inside is rounded so that the finished piece takes on the identical shape of a glass beaker, yet is not as fragile in use. After a minimum of polishing the beaker is ready for service. These chemical aides are usually processed from an amber shade of the material rather than clear white, which doesn't seem to retard their sale.

Gasoline gages for air craft and many other precision gages and instruments used in engineering and laboratory work are turned from standard shapes, and invariably transparent cast phenolics are chosen for the purpose because of their inherent strength and dependability through their ability to resist shock. Modern clocks are simply and easily made from stock blocks and for these, machining operations are limited to drilling holes in the face of the clock for hands and numerals, and turning a space in the rear large enough for insertion of the clock movement. The vast array of colors available makes it possible to fit these into any decorative scheme. In making advertising signs and letters, the individual letters are actually cast to the approximate size in lead molds and the fabrication is almost entirely a matter of casting and installation.

The method of fabricating cast phenolics is strikingly similar, no matter what type of product is being considered. Rods, tubes and sheets are first cut into blanks of a proper size for the finished object, either with thin abra-

Manufacturers of costume jewelry are big consumers of cast resin. Examples made of Phenalin may be seen in the upper illustration. J. M. King Co. made the cast resin chessmen (center) while the brush backs (below) are made of Bakelite cast resinoid



# Molds

PROPERLY DESIGNED . . .  
PERFECTLY EXECUTED . . .

can provide that extra ten percent of production that will bring your costs way down . . . can provide that extra beauty of finish and appearance you demand . . . can cut your rejects to a minimum and give your parts greater strength at lower costs.

Our engineers, through years of serving the leading molders of the Midwest, have learned the art of achieving the utmost in mold efficiency.

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INDUSTRIAL TOOL AND DIE COMPANY  
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NOW in our new plant

## MOLDS

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Our new and enlarged plant has been re-equipped with the most modern precision machinery and hydraulic hobbing presses.

Call upon us for aid in designing all types of plastic molds from the simplest to the most intricate.

FORTNEY MFG. COMPANY

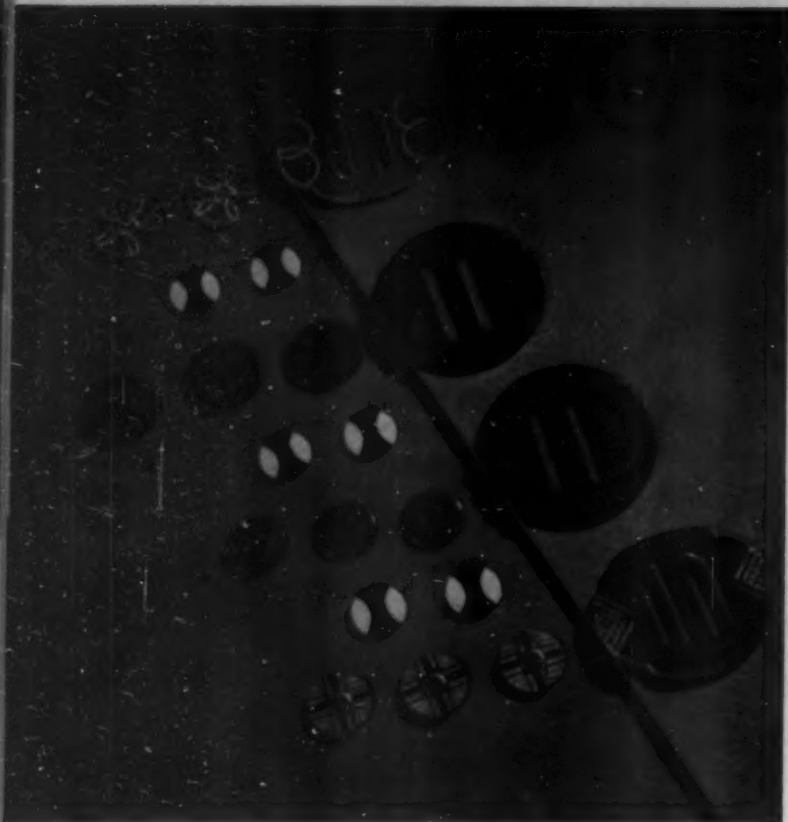
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*Since 1917  
working for leading molders*

Master fabricators  
of CAST RESINS



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Handbag Ornaments  
**ACE PLASTIC NOVELTY CORP.**  
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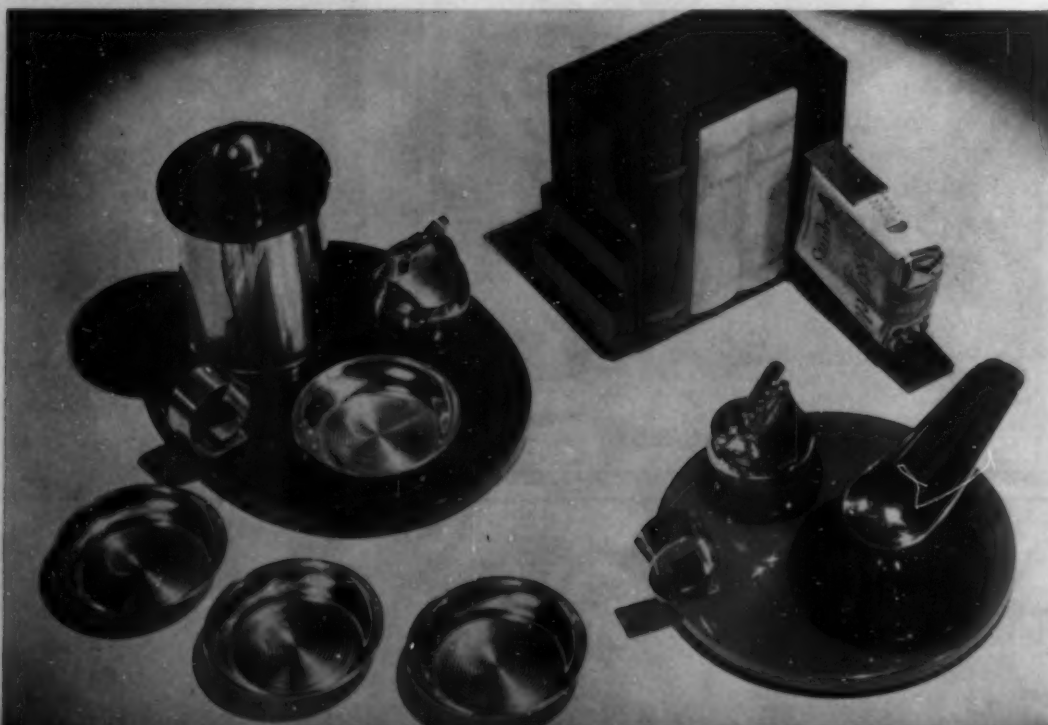
sive cut-off wheels, or a slicing machine which requires softening of the material by heating. When using the slicing machine, the cast resin is held stationary and a knife is forced through the material as it is carried forward on a reciprocating slide. The knife is flat on its upper surface and is ground to a sharp edge which is honed. This slicing machine cuts without waste and if the knife is kept sharp and the material properly softened by heating, there is no danger of chipping the blanks being cut. The blanks fall into a basket submerged in water in a shallow tank below the knife and are ready for the next operation.

Band, circular or hack saws are used for cutting special shapes not available in stock castings. When working with small pieces, oftentimes designs are traced on a sheet of cast phenolic in a size practical to handle and several thicknesses of sheets are fastened together to be sawed at one time, to give the pieces their outline. A power jig saw operating at a speed of 1000 RPM is recommended for this purpose. Beveling machines or shapers are used for rounding edges, and rod turning machines for turning beads, ferrules and similar objects from rod stock. Irregularly shaped pieces such as chessmen, lamp base parts and candlesticks are turned on lathes or milling machines. Sand discs are used to smooth the surface of pieces to be cemented together and various grades and qualities of cement are available for different work.

Carving is accomplished on small steel or carborundum wheels ranging in size from  $\frac{3}{8}$  in. to  $2\frac{1}{2}$  in. in diameter and  $\frac{3}{16}$  in. to  $\frac{1}{2}$  in. thick. Each design or cut requires a suitable size grinding wheel to accomplish the work specified. The grinding wheel moves at a fast rate of speed while the operator holds the piece to be carved in both hands and guides it against the wheel,



Top—Transparent and translucent buttons and buckles of Bakelite resinoid made by Iowa Pearl Button Co. Center—Stock shapes of Marblette from which similar articles are sliced. Below—Smoking sets of Marblette combined with metal are neat in appearance and easy to keep clean





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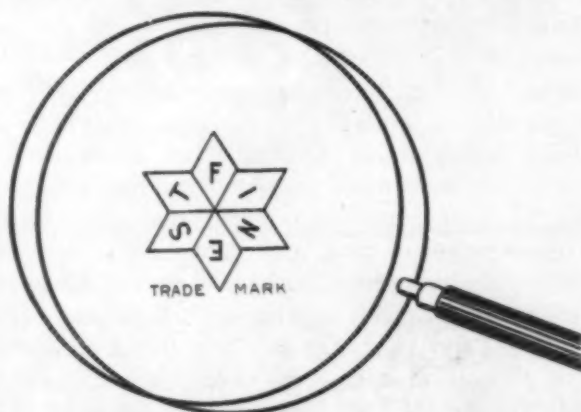
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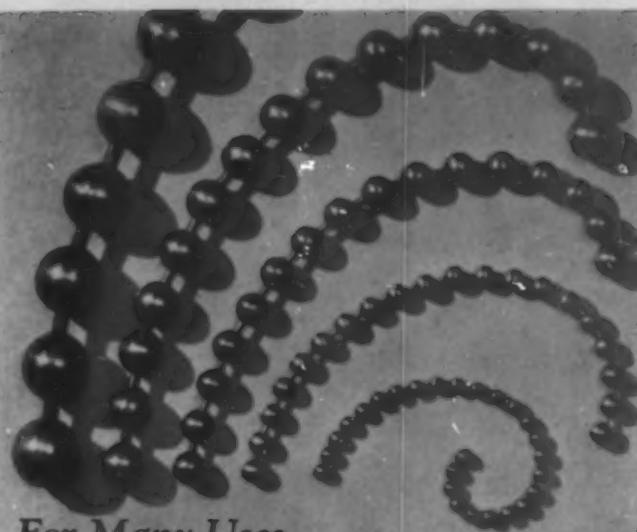
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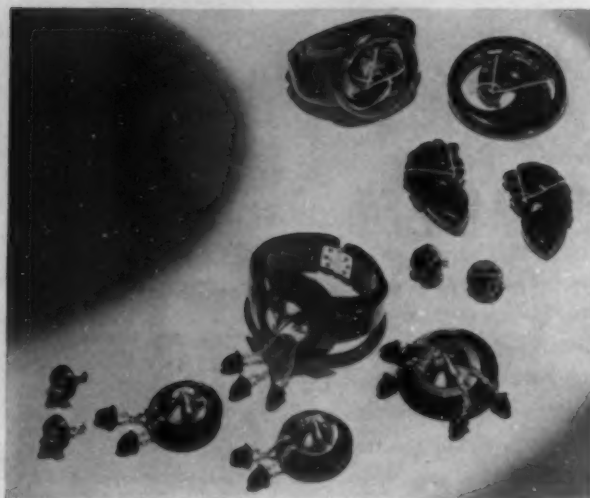
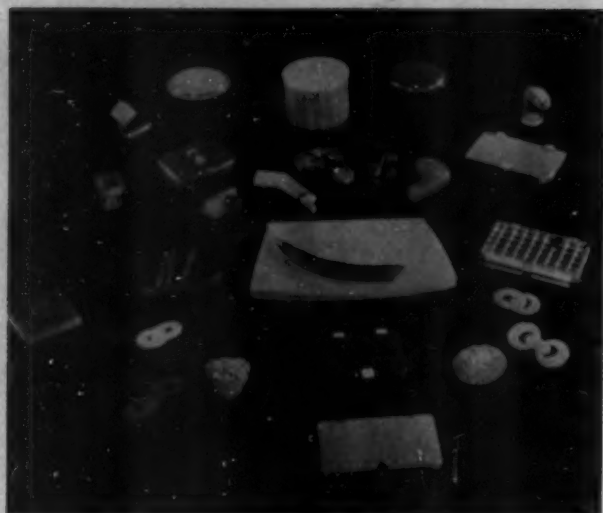
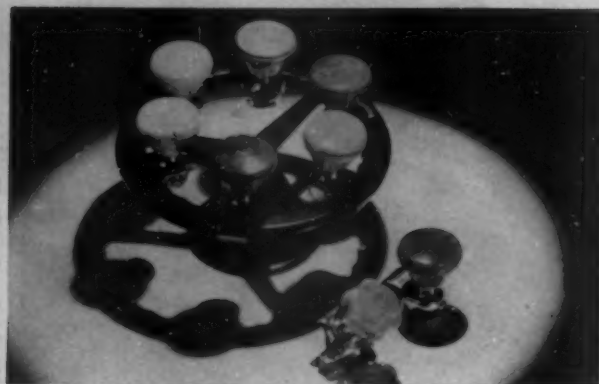
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Today a great number of clients will testify that the Butterfield combinations of modern, start-from-scratch equipment and layout, plus sound engineering background has produced a series of exception moldings... soundly engineered, smartly produced and delivered without hitch or delay.

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Upper left—Stock sheets, rods and tubes of Catalin and Prystal (clear cast resin). Upper right—Steering wheel spinner knobs of Marblette. Lower left—Cigaret cases, boudoir brushes, combs, umbrella handles, etc. (Catalin). Lower right—Costume jewelry fashioned by Ace Plastic Novelty Corp. from Marblette

working out the most intricate patterns. Skilled operators may do hundreds of pieces with the same design with almost no variation in the number, depth and arrangement of cuts. Directly behind each grinding wheel is a small, powerful suction tube with funnel shaped opening, which picks up all waste material as it is ground by the wheel and removes it from the building. In the usual set up of fabricating shops a regular production line is established in which these little wheels are all driven from a central power drive located below or above the long bench at which workmen are seated comfortably to perform these different operations.

An assortment of steel drills is essential for pieces in which holes are to be inserted. In the manufacture of jewelry, two-spindle machines are used for drilling holes in bracelets and similar articles, and the spindles can be adjusted to bore both holes at the same time anywhere from  $\frac{1}{8}$  in. to  $1\frac{1}{2}$  in. apart. Four-spindle machines for drilling holes in buttons can be arranged to drill one, two, three or four holes at one time. Chucks for different size buttons are usually included with the equipment. Pins, clips or other metal attachments are either screwed into place in holes drilled for the purpose, or forced in on foot-treadle operated machines, which are often especially designed in individual shops.

The turning, sawing and engraving operations dull the surface of the material which must be polished to restore its natural luster and depth of color. For small pieces, this operation is generally accomplished by means of tumbling barrels where the articles are ashed and allowed to roll with wood pegs for a suitable length of time. Then they are sifted and permitted to roll for an additional period of time with burnishing compounds and pegs. If a high permanent luster is desired, the pieces are rolled a third time together with polishing cream and pegs. Large pieces are usually polished on buffing wheels with special compounds as described in an article called "Finishing Plastic Surfaces" which appears elsewhere in this issue.

Cast resins are often harmoniously combined or decorated with other materials. For example, white metal alloy may be flowed into a carved design and since the alloy liquefies at a low temperature, there is no danger of its marring the cast phenolic. These materials are also susceptible to marking and can be decorated with roll leaf stamping in gold, silver, bronze or other metallic colors. The ornamentation may take the form of metal inlays, or clusters of sparkling rhinestones; in fact, the possibilities for combinations and decorations are limited only by the imagination of the fabricator.



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## THE FABRICATING OF CELLULOSE PLASTICS

(Continued from page 152) great beauty, utility and durability. This type of plastic is very popular for women's handbags, lamp shades, airplane windshields, laminated safety glass, combs and many other products that lend themselves to a plastic of this type.

The more prominent methods of fabrication for these plastics under discussion are cutting, blanking, beveling, stretching and forming, flowing, veneering, cementing, polishing and staining. They can also be decorated with gold-leaf or bronze. Heated embossing dies are used for that purpose. Colored decorations are applied either by engraving the design by hand or by machine embossing and then filling in with decorating lacquer.

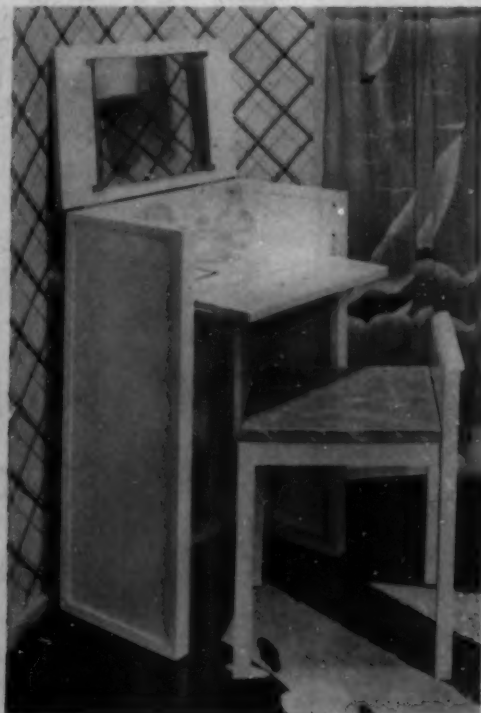
Since cellulose plastics were the first of the plastics in this country, fabrication methods used for this type are pretty generally known. However, it might be well to refresh one's memory by briefly giving the methods employed in each operation. A thin sheet, for example, can be cut with the usual paper-cutting devices, while thicker sheets should be sawed. In blanking various

shapes can be made. Dies, such as those used in cutting leather, or punches, such as are used in metal work, may be used. Beveling is accomplished on routing machines.

Stretching and forming is done by pre-heating and pressing in unheated dies. Pre-heating should be done in boiling water on a steam table or a rheostat-controlled electric hot plate. On being removed from the die, articles should be plunged into cold water immediately so as to chill them sufficiently to retain their shape. For deep forming or stretching and where heavy stock is used, a screw press operating in a sink of boiling water is necessary. As soon as the article is formed, the whole apparatus is plunged into cold water. Hollow toys and similar objects are made by blowing steam between two pieces of sheet plastic previously placed in dies. In covering tapered articles and other objects of irregular shape, a tube should be immersed in hot water and then stretched on a heated mandrel. It should then be cooled, removed from the mandrel and slipped over the article to be covered. On being thrust into hot water, the plastic shrinks and gives a tight covering.

Sometimes, as in the case of tooth-brush handles, ac-

These adding machine and typewriter key tops are molded from cellulose acetate while the modern dressing tables below are finished with a hard chip-proof (resin base) enamel and are fitted with Pyralin tops. The first two are made by Vogue Mfg. Co. That at the right was designed by Eugene Schoen for Albert Grosfeld, furniture manufacturer



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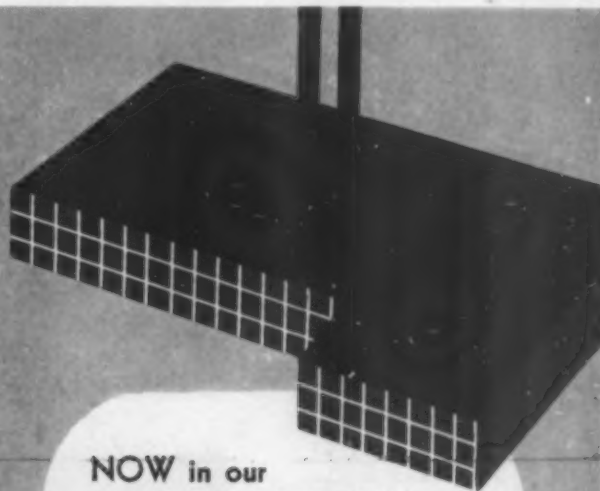
Testing  
Research  
Development  
Applications

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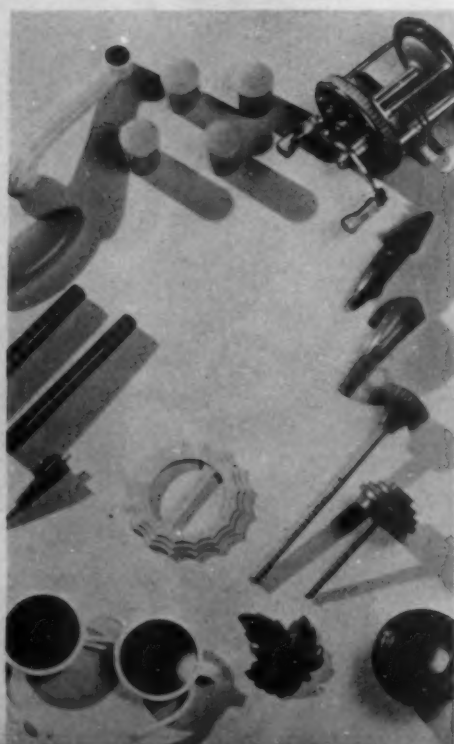
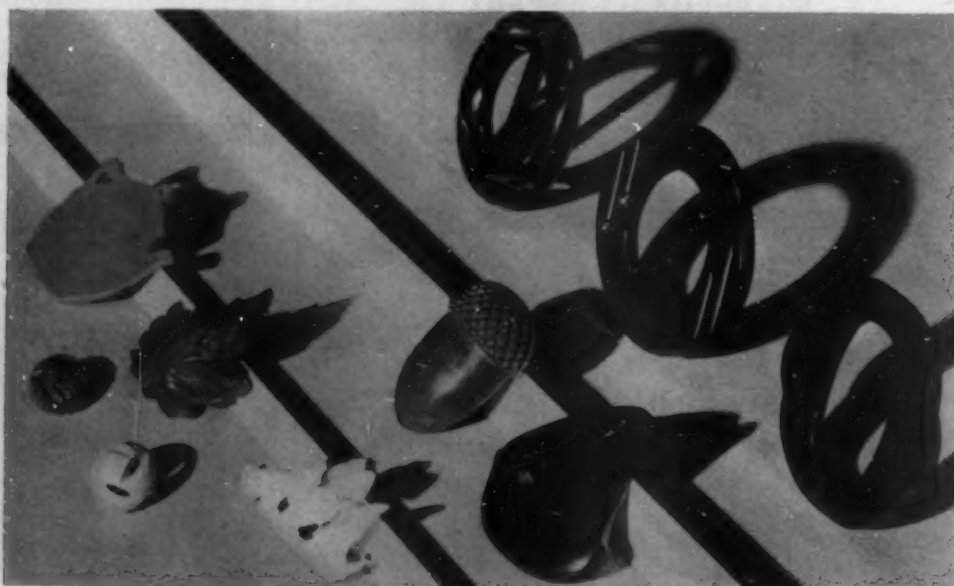
tual flowing of the plastic is necessary. The dies used are usually pre-heated with internal circulation of steam. After the article has been formed, the dies are cooled with water. In this type of operation, hydraulic pressure is used. Veneering, or covering of objects with plastics, requires that the material be softened to a point at which it resembles wet chamois. This softening is quickly accomplished by immersion in a mixture of one part acetone and three parts water. The plastic is then stretched over the object and cemented at the edges.

Pieces of plastic can be readily cemented together with a mixture of certain solvents. For most work a mixture of 40 percent amyl acetate and 60 percent acetone is suggested. To cement plastic to wood, the latter is first painted with a solution of scrap material in the solvent mixture mentioned and then allowed to dry so that the cement will penetrate the pores. Then both wood and plastic surfaces are brushed with the plain solvent mixture and held together until dry.

Fabricated plastic articles can be polished on muslin buffing wheels with a wax dressing or polishing compound. Sometimes it is advisable to give rough surfaces a preliminary smoothing by buffing with wet pumice. Small articles, such as umbrella tips are frequently polished by dipping them momentarily in a solvent such as glacial acetic acid, or by exposing the article to the fumes of a solvent mixture such as methyl alcohol and star solvent on a fifty-fifty basis. Surfaces of plastic articles can be successfully stained by dipping in a solution of aniline dye of the desired color dissolved in diacetone alcohol or other solvent of like nature.

The methods given here are the ones most generally and successfully used, but do not by any means describe all of the fabricating processes to which this type of plastic lends itself. Specialized steps in the manufacture of individual articles are not included. Mirror setting, comb setting, bristling brushes, for instance, each requires its own technique.

Cellulose acetate is available in molding powder as well as in sheets, rods and tubes and the various items shown below are molded of Plastacele



# **MACHINERY AND EQUIPMENT**

PAGES 203-278

**HYDRAULIC MOLDING PRESSES**

**INJECTION MOLDING PRESSES**

**AUTOMATIC MOLDING PRESSES**

**MOLDING PLANT EQUIPMENT**

**FLEXIBLE METAL TUBING**

**HYDRAULIC CONTROLS**

**HEAT FOR MOLDING**

**FINISHING PLASTIC SURFACES**

# THE MODERN MOLDING PRESS

by HOWARD F. MACMILLIN

IN THE MODERN SELF-CONTAINED MOLDING press the plastics industry now has a production machine especially developed for its own particular requirements.

The conventional compression molding press of the past has been largely a heritage from the rubber goods industry where the simple hydraulic hot plate press has long been employed for vulcanizing. In plastic molding this type has been used with hand molds. The so-called semi-automatic press for operating molds with knockouts has been essentially an alteration of the basic press. This added means for mounting the molds and auxiliary hydraulic rams for opening the press, providing power to separate the molds and to actuate the knockouts.

All such conventional molding presses have been operated in groups from the well known water pressure accumulator system as employed without essential change for half a century.

The modernization of the molding press has involved a radical break with the past in methods of both generating and controlling the molding pressure. This is of outstanding interest to the molder inasmuch as the press has thus been endowed with new and definite performance characteristics making possible numerous improvements and economies of operation.

In common with many other classes of machinery eye-appeal has also been recognized in designing press frames in the current streamlined style. This has included structural changes such as the use of rolled steel plates to

replace many of the castings and rods which compose the familiar construction.

In this discussion we confine our attention to the hydraulic press for molding thermosetting resins. This we identify as "compression" molding in contrast with the quite new "injection" method which is limited at the present to the molding of thermoplastics.

The hydraulic press which qualifies for the title of "modern" must, we feel, possess a number of definite features, with other desirable accessories available to the molder at his option.

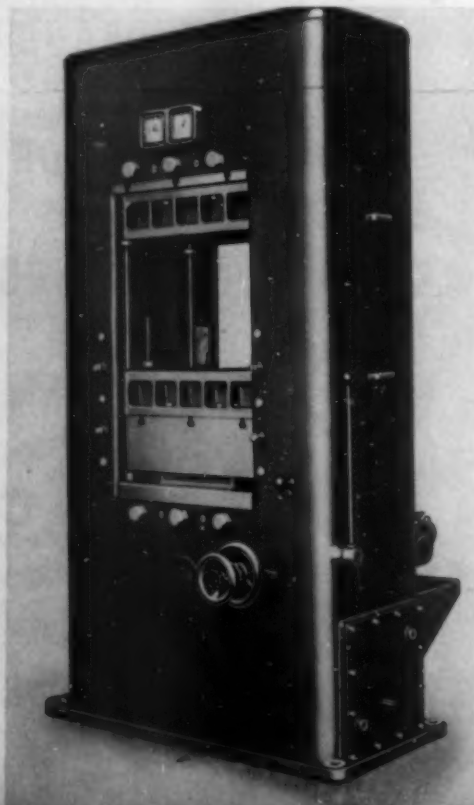
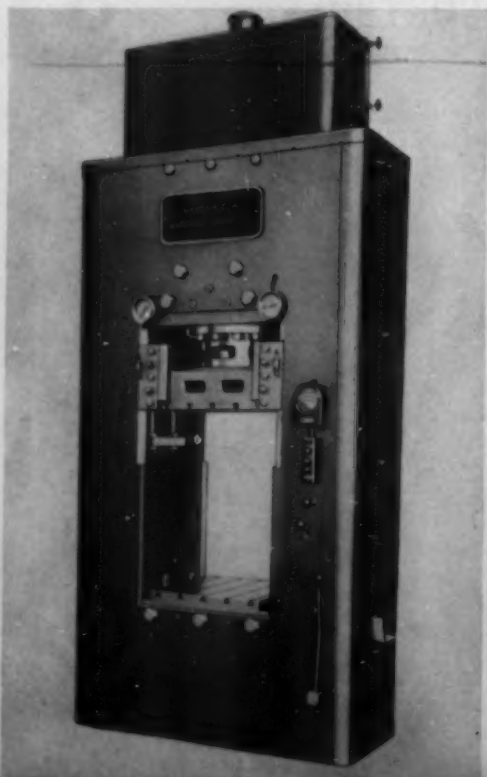
First of all, the modern molding press is self-contained with integral electric motor drive. Here, of course, is the universal trend for machines of all kinds. However, the advantages of individual over group drive are far more pronounced in the case of hydraulic presses.

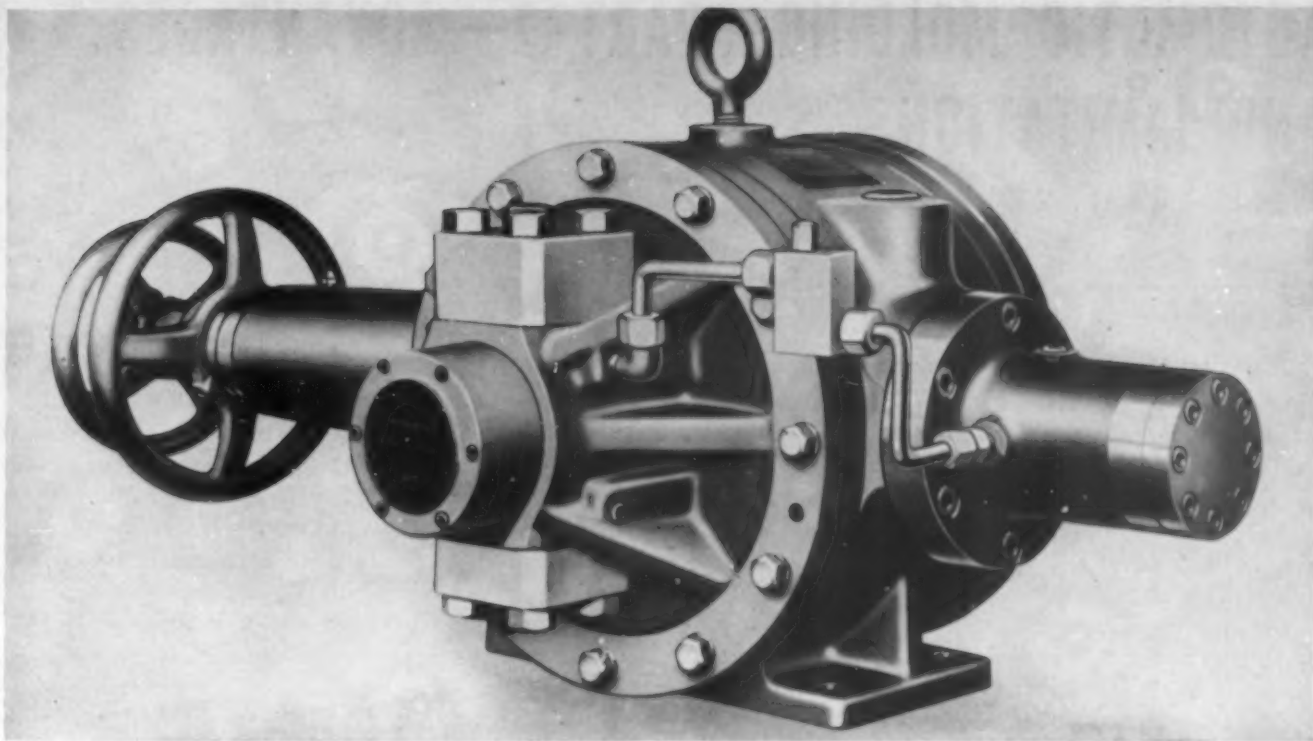
The self-contained press is unrestricted as to plant location and may be moved readily if required. It is quickly and economically installed, being completely assembled with motor when received. Total floor space is economized as the self-contained press with its power unit requires no more room than a bare press frame.

Oil is used as the fluid medium in the self-contained press instead of water. A high grade lubricant is essential. This is entirely practical in a compactly self-contained unit but obviously not in an extended accumulator system with the manifold chances of waste.

Oil in turn opens up a host of new construction possi-

Two modern self-contained hydraulic molding presses. The one at the left has downward stroke with hydraulic power cylinder overhead and is equipped with an independent hydraulic ejector within the bed. At the right is an upward action molding press with grids and mold knockouts. Completely self-contained with radial pump power unit at rear. (Photos courtesy Hydraulic Press Mfg. Co.)





Radial type pump with automatic pressure and volume control for operating modern self-contained plastic molding presses. (Photo courtesy Hydraulic Press Mfg. Co.)

bilities. The properly designed press takes full advantage of it. Corrosion of working parts is no longer a problem as with the water pressure press. All members of the pump, controls and valves subject to wear are made from modern alloy steels, heat-treated according to the duty they are expected to perform.

The high viscosity of the oil makes possible other radical changes. This includes the use of close-fitting packless pistons in all operating elements; also press rams fitted with permanent metal piston rings working in smoothly bored cylinders. Thus pressure packings in their familiar perishable form can be virtually eliminated with proper press design.

All of the foregoing means elimination of the most prevalent sources of maintenance expense in the old time hydraulic press. Furthermore, with the new press, thorough automatic lubrication of all working parts is incidentally obtained.

The proper source of pressure for the modern press is a variable delivery oil pressure pump. This is the multiple, radial plunger type, arranged to operate at full electric motor speed. The pressure flow from such a pump is smooth. For example, a five plunger pump driven at 1200 R.P.M. will develop 100 pressure impulses per second, which is considerably in excess of the frequency of commercial alternating electric current.

The working parts of the usual radial type pump are incorporated in a double rotor arrangement, one disposed within the other but independently mounted on anti-friction bearings. The inner rotor is the pressure member with a series of radial cylinder bores. Plungers

reciprocate in the cylinders, pumping inwardly to a stationary distributing valve spindle around which the rotor is revolved by the drive shaft coupled to it. The outer rotor carries the plunger crosshead guides and is shiftable eccentrically with respect to the cylinder rotor, to cause the plungers to reciprocate. Volume and direction of pump output are determined by the amount and direction of this variable eccentricity and resulting length of plunger stroke.

The variable delivery feature of the pump is most important in the operation of the modern molding press. With proper control mechanisms this affords entirely new and very effective means for complete regulation of the press functions, as to pressure exerted, rate of pressure application and speed of ram movements. The control mechanism for regulation of pump pressure output is basic. It functions by shifting the pump stroke to neutral when peak pressure is reached. Thus full pressure may be sustained indefinitely with very small power consumption. Furthermore, pressure is maintained accurately and without fluctuation.

The pressure control usually consists of a spring and a pressure piston each acting on the pump stroke shifting mechanism. The spring normally holds the pump on full stroke. The pressure piston acts in opposition to the spring. Hydraulic pressure developed by the pump is applied to this piston. When sufficient pressure is exerted to produce a total force on the piston that will overcome the opposing force of the spring, the pump stroke will be shifted to neutral. The pump will then work at practically zero (Continued on page 264)

# AUTOMATIC MOLDING—PART 2—ADVANTAGES AND LIMITATIONS

by VICTOR I. ZELOV

(Part One appeared in the September 1937, issue)

PROGRESSIVE MANAGEMENT THROUGHOUT ail industry is on the alert for new means and methods to produce more and better goods at lower costs. In the plastics industry, in particular, rapid change is taking place. The field is constantly broadening, adding comfort, beauty, safety . . . lowering costs of many articles . . . making possible many new products.

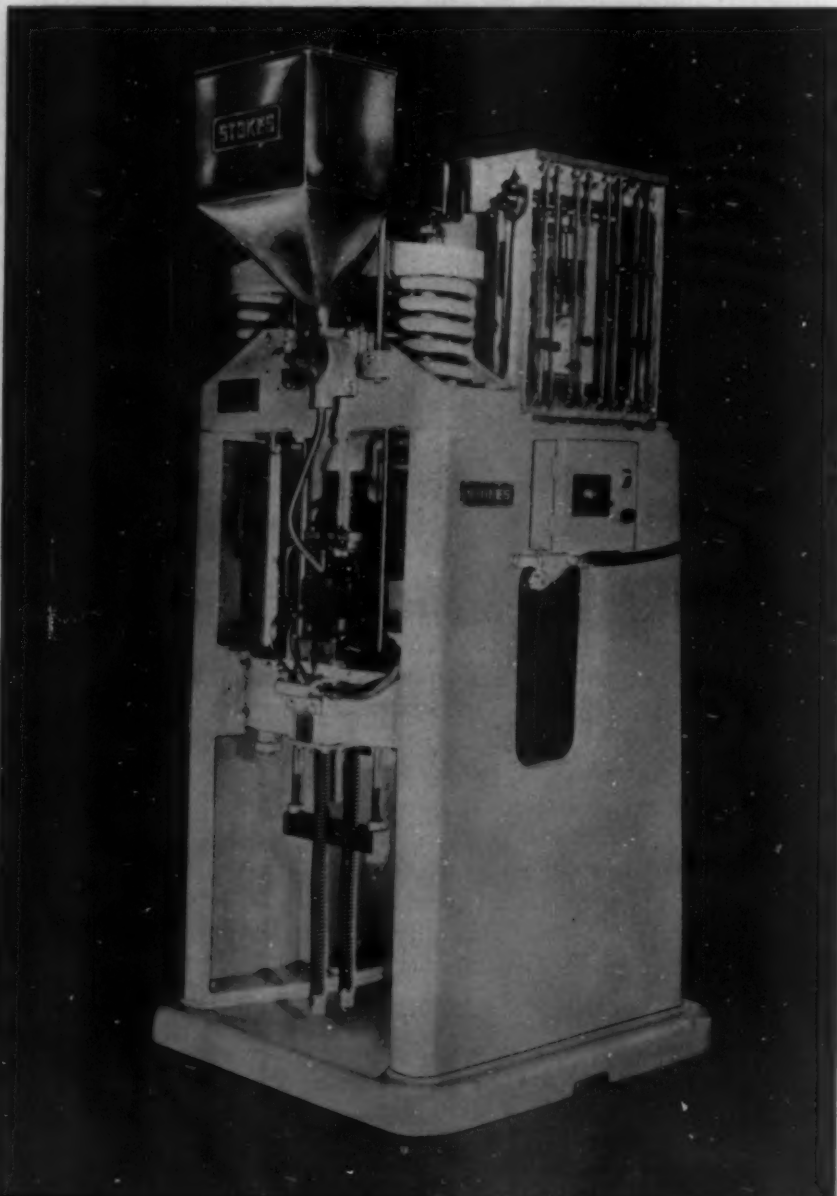
The industry is expanding, creating new jobs and employing more men. It is evident that the time is ripe to adopt automatic production methods for some of the simpler and well established processes of plastic molding. And it is a fact that a considerable percentage of existing and new parts can be molded, readily and profitably, in the new fully automatic presses now available.

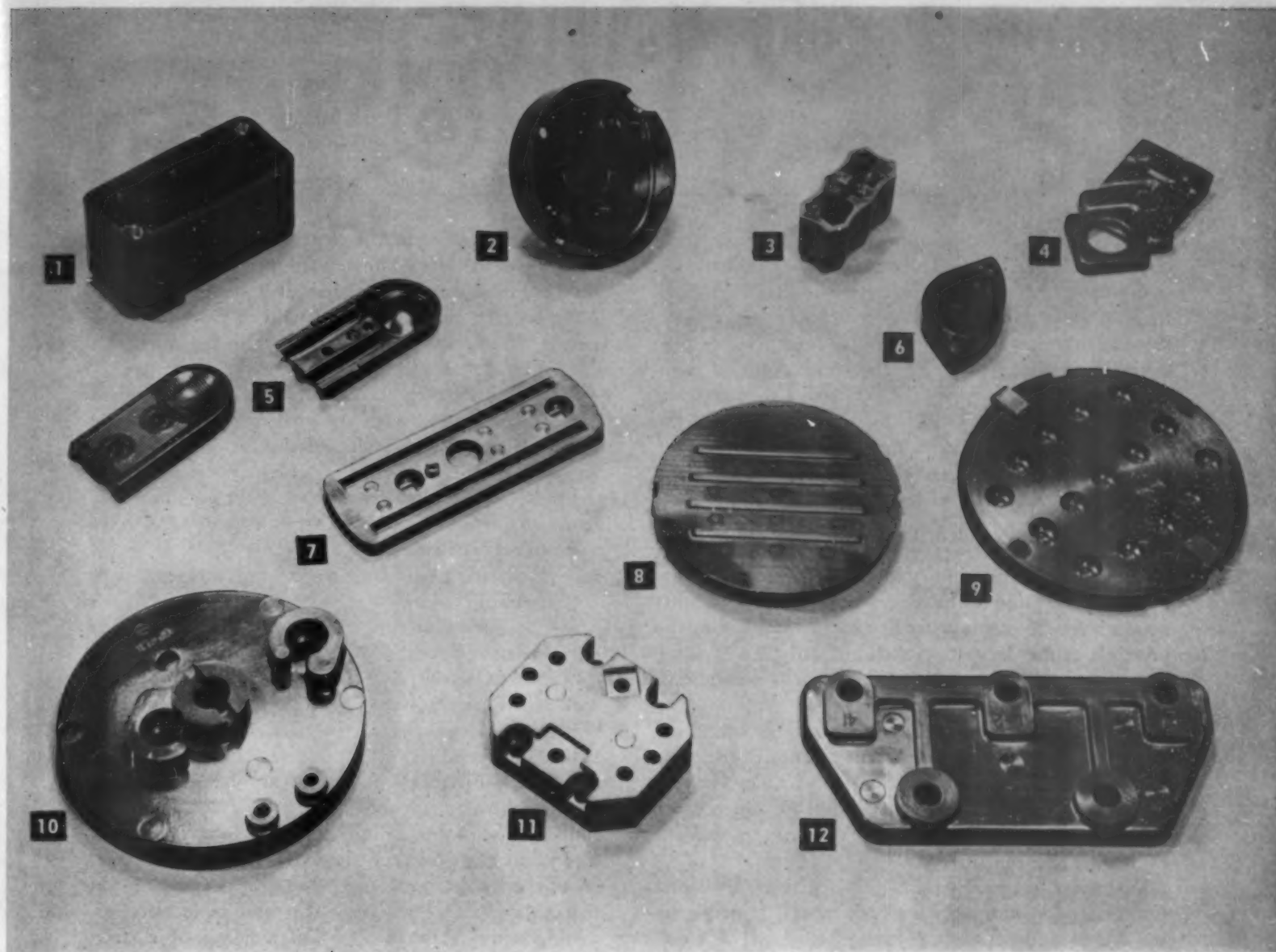
Automatic production methods are now possible be-

cause molding practices have reached a high state of exactness and uniform molding compounds are available. The process of molding is divided into a series of simple movements, quite uniform and rather monotonous. Measuring of compound, placing it into a cavity or a mold, opening the valve or turning a lever, maintenance of prescribed temperature and pressure, lifting the piece out of mold and ejecting it, are well timed, uniform and simple operations—all readily made automatic.

The great variety of molded parts allows only a general discussion of advantages and costs involved—yet, the basis of comparison is easily established, subject of course to wide corrections in many cases. There is an average relation between the cost of molding material and finished plastic part that might be accepted as 1 to 3. Simpler parts and those of a heavy bulk might cost less than triple the cost of mate- (Continued on page 258)

© 1937—F. J. Stokes Machine Co., Philadelphia





At the left: A new type of press which is completely automatic, operates electrically, is entirely self-contained. The press requires only one electric connection to supply current and a compressed air supply to remove the molded parts and clean the mold. Above: An assembly of some parts which have been successfully produced on an automatic molding press: 1. Contact block for vacuum cleaner. 2. Part for fire detector. 3. Knob for electric toaster. 4. Control box for textile machine. 5, 6. Electric transformer covers. 7. Collector cover for textile machine. 8. Switch base. 9. Gear regulator board. (All photos, F. J. Stokes Machine Co.)

# INJECTION MOLDING MACHINES

by J. F. GEERS

INJECTION MOLDING IN THE UNITED STATES can be considered as of commercial importance for only the last two and one-half years. In this relatively short time, however, tremendous progress has been made. Prior to this time little attention had been given to this method for the production of castings from thermoplastic materials, largely due to the fact that suitable materials were not available in this country. Much more progress had been made abroad in the field of thermoplastics, which enabled them to use this method of molding at a much earlier date. In fact, injection molding machines have been successfully used abroad in the production of castings for the last ten years.

The process of injection molding undoubtedly owes its original conception to the die casting industry. For this reason a few moments must be spent in examining the principle of the die casting machine, and then deciding to what extent this same principle has been worked into the process of injection molding.

The first die casting machines were used in the manufacture of bullets and printing type. Although the exact date of the invention of die casting machinery is very much in dispute, historians interested in the subject agree that the machine developed by E. Peluze in 1856 was one of the first ones in this field.

Fig. 1 is a sectional view of this machine. Its operation clearly demonstrates the fundamental principles of the die casting process. Referring to Fig. 1, the molten metal flows through the opening B, and down into the piston chamber. The valve C is then moved back

until the beveled surface A closes the opening B. The plunger E is then forced downward in the cylinder. The metal is forced through the channel F, out of the nozzle D and into the die. The valve C is then moved forward cutting off the molten metal sharply in the nozzle D. The piston is then withdrawn and the cycle repeated.

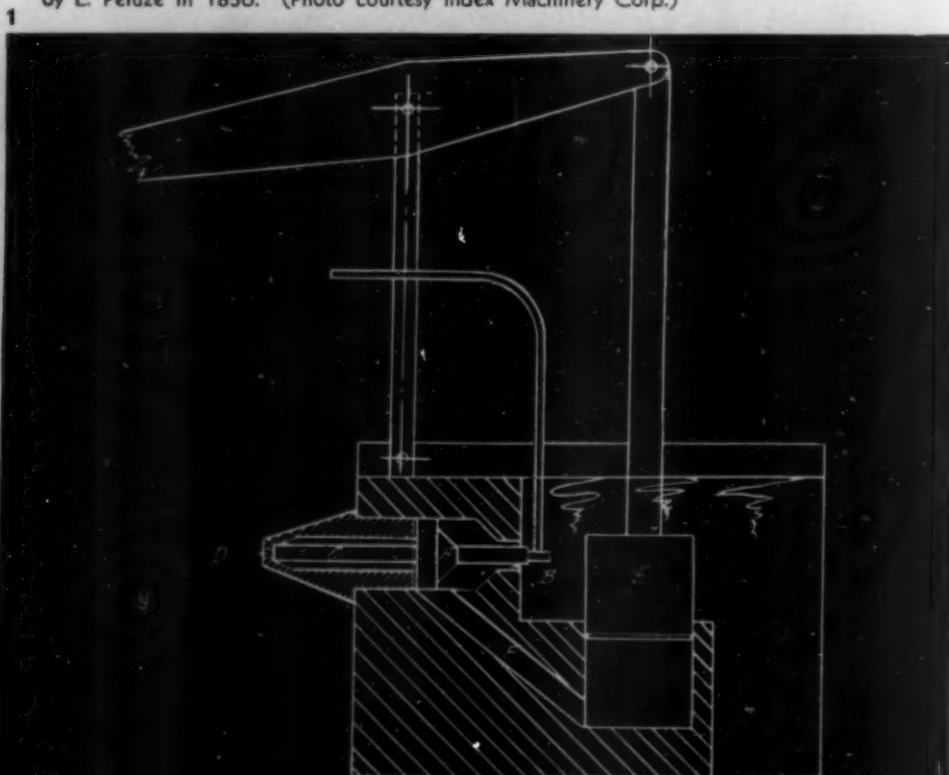
This early type of die casting machine was indeed crude in comparison with the modern machines in use today. However, the fundamental principle underlying the operation of the modern automatic machines is identically the same as it was in the machine built by E. Peluze in 1856. This principle can be summarized into two basic operations:

- 1—The heating, into a molten mass, of the metal to be molded;
- 2—The forcing of this molten mass into the die by some mechanical or hydraulic means.

In considering the process of injection molding we will look at it from the viewpoint of basic principle, which principle is identical in every machine on the market today. The material injected must be a thermoplastic material. This means that the material will become plastic when heated and will not solidify until it is cooled. The process of injection, therefore, causes only a physical change in the material. The gates trimmed off of the molded parts and other scrap material can be regranulated and again used, the same as in metal die casting since, through injection molding of thermoplastic materials, no chemical reaction has taken place in the material.

*(Continued on page 211)*

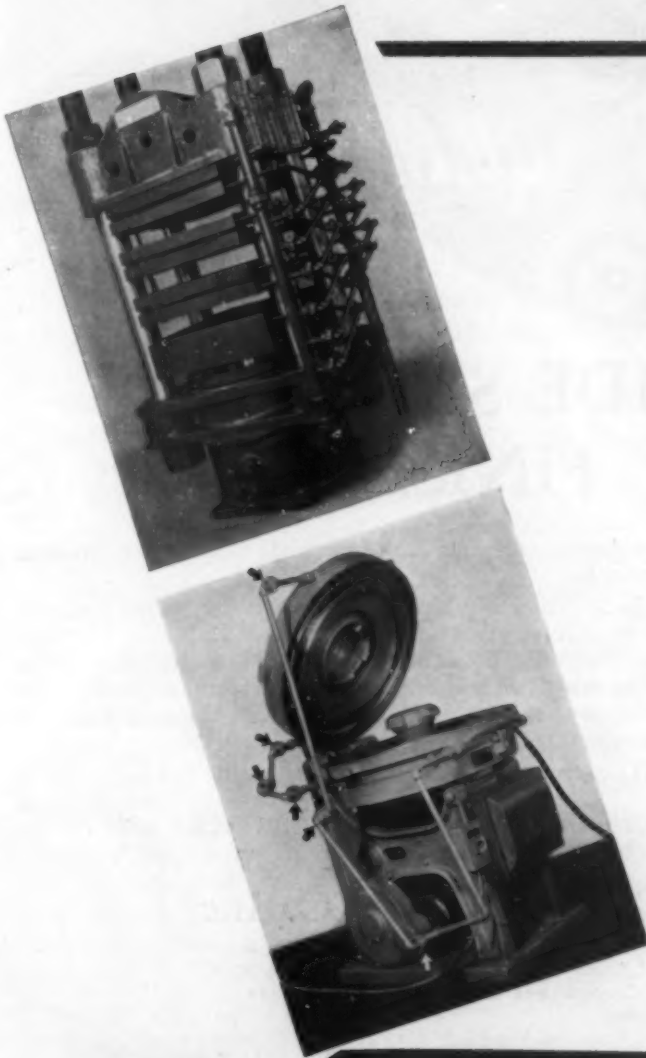
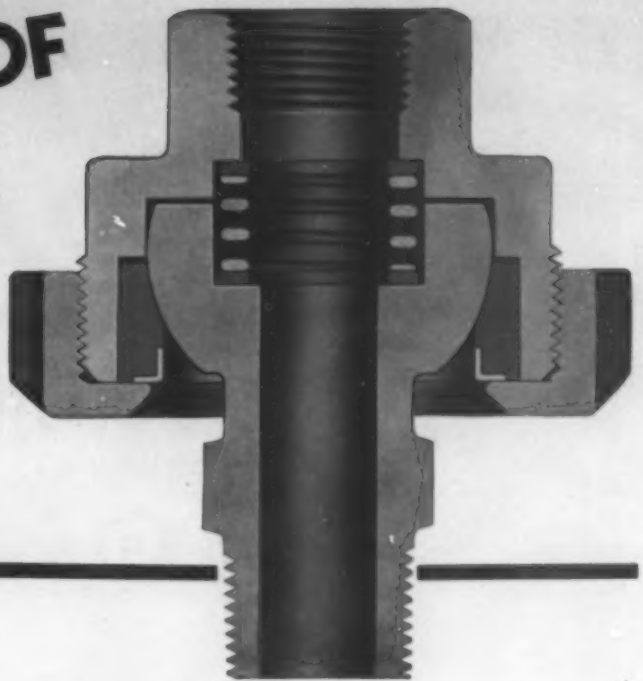
Sectional view of one of the first die casting machines developed by E. Peluze in 1856. (Photo courtesy Index Machinery Corp.)



# FOR LEAK PROOF

## *Swivel*

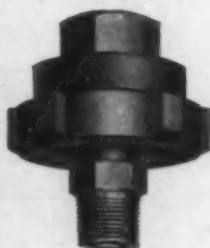
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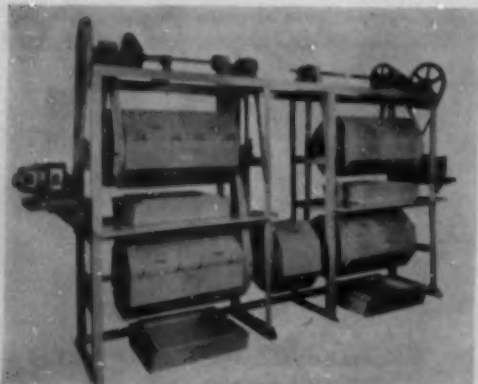
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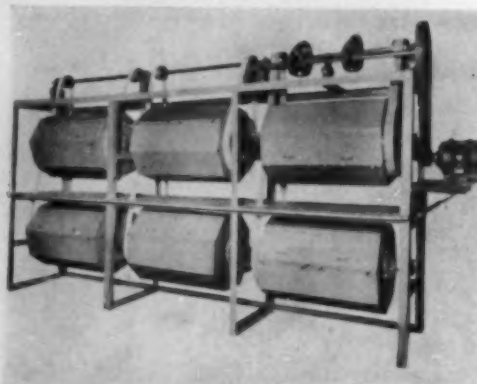
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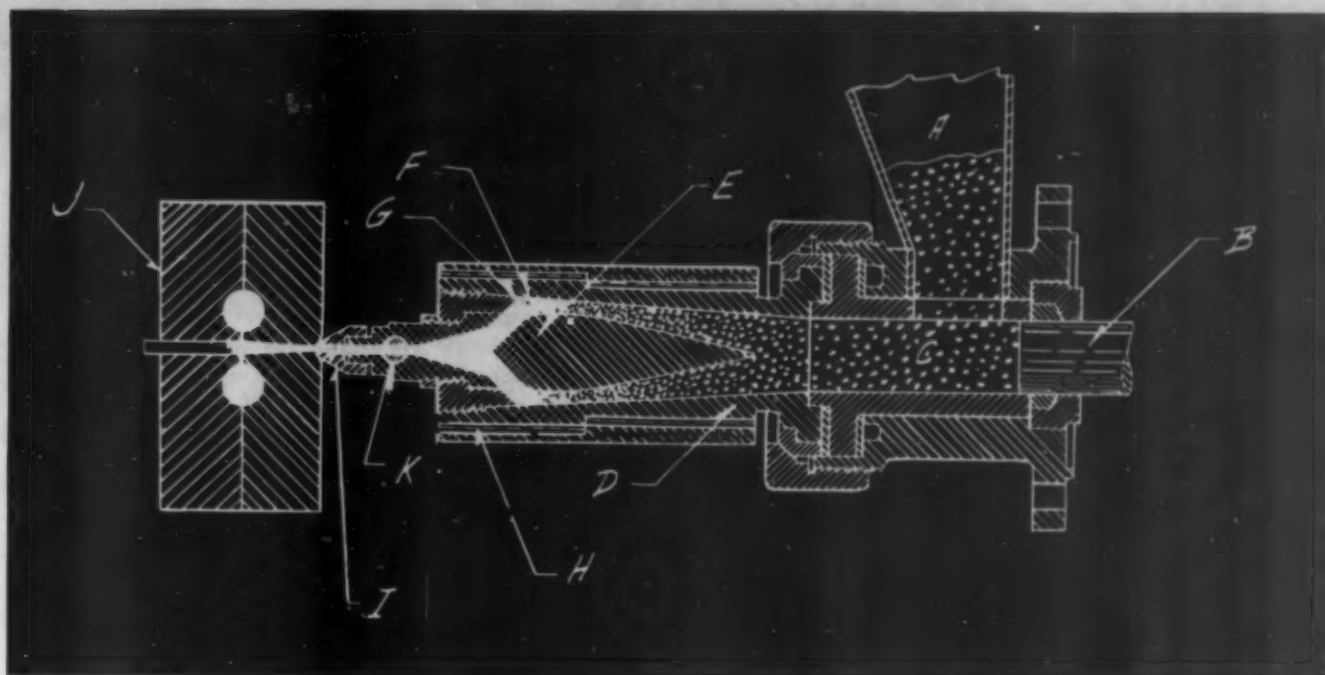
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Typical heating cylinder on injection molding machine

(Continued from page 208)

The heating of the thermoplastic materials is not quite as easily accomplished as the melting of the metal in the die casting machine. The temperature to which a thermoplastic material can be subjected without danger to it is rather critical. The thermoplastics have a relatively high specific heat, but are very poor conductors of heat. This means that the material requires a large quantity of heat to soften it, but it does not conduct this heat very well within itself. Hence, to increase the outside temperature of a mass of plastic material excessively would cause decomposition and burning of the outside surface, before the heat would penetrate through the mass and soften it sufficiently to cause it to flow. In order to overcome this difficulty the heating chamber for the injection molding machines must be constructed so that the inside of the material will be heated as well as the outside, and the cross-section of the material be kept as thin as possible.

In Fig. 2 a typical heating cylinder used on injection molding machines today is shown. The material is loaded into the hopper A in a granular condition. It is automatically fed from the hopper by mechanical means into the sleeve C. The piston B advances and forces the material through the sleeve C and into the heating cylinder D. The cross-sectional area of the material as it enters the heating cylinder is too great to permit thorough heating without burning. For this reason the torpedo shaped spreader E is mounted inside of the heating cylinder. As the material is forced through the heating cylinder, the spreader causes it to spread outward and pass between the inside walls of the cylinder and the outside surface of the spreader. This cuts down the thickness of the section of material and permits it to be thoroughly plasticized. At the point F, the spreader is in contact with the inside walls of the cylinder and is

heated here by means of conduction. The outside of the heating cylinder is surrounded by electric heating elements H, which heat it to the desired temperature. By the time the material has reached the point G it is thoroughly plasticized, and converges to pass through the nozzle I and into the mold J. A cock K is placed in the nozzle and is mechanically opened and closed when using materials that become exceptionally plastic and pour or ooze out of the nozzle between operations of the machine.

Automatic temperature controls are provided to properly regulate the temperature of the material. This is a very important factor to prevent overheating and discolorations. Automatic operation or cycle control is another very important factor, and its importance is all too frequently underestimated.

An automatically controlled cycle, eliminating the human factor, is the only means to ensure against discoloration after the proper temperature and cycle have been determined. We will take, for example, a thermoplastic material for which the correct injection temperature is 375 deg. F.; the rate of injection is 50 pounds of material per hour at 6 ounces per injection, and the result is the completion of one cycle every 27 seconds.

Although the automatic temperature controls will regulate the temperature fairly accurately we must allow that it is quite impossible today to control the temperature quickly in case the operator fails to pull the starting lever every 27 seconds. The result of such failure is that the material in the heating cylinder is subjected to 375 deg. F. heat for a longer time than originally decided upon, and discolorations or flashes are usually the consequence since the pressure is adjusted for a definite stage of plasticity. Most materials will not stand the proper injection temperature for an extended time period without decomposition, and for that reason we strongly urge the use of automatically oper-

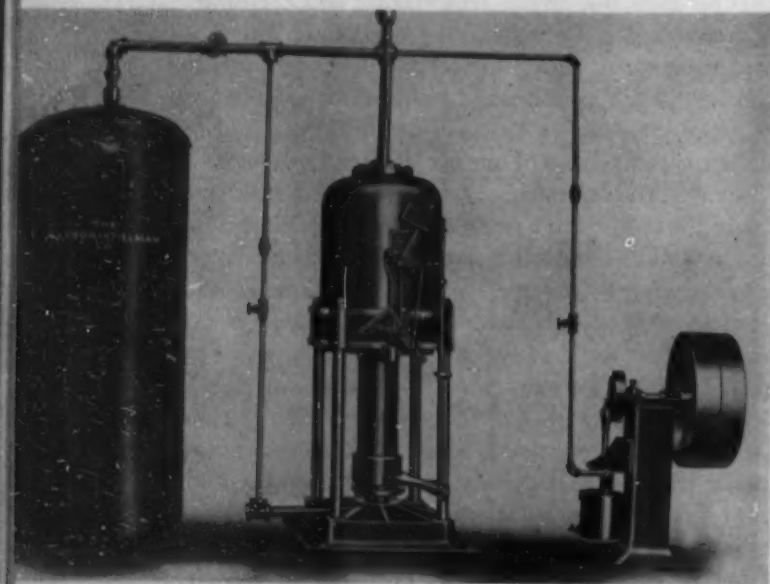
(Continued on page 252)

# MOLDING PLANT EQUIPMENT

WITH THE RAPIDLY GROWING ACCEPTANCE and appreciation of molded plastics in widely diversified phases of industry, molding shops all over the country have been impelled to perfect methods of production to keep pace with demands made upon them. Since the beginning of this molding business, machinery and accessories have been constantly in the process of improvement and broadening to do the job better than that previously used. And as new and improved ideas are expounded along these lines, molders are anxious to take advantage of them by renewing and expanding their equipment. Consequently, few if any responsible molding plants are conceived and run on a shoe string, for it requires a sizable outlay of money to get together and maintain suitable equipment to maintain production on anything like a dependable schedule. The amount and nature of the equipment vary, but the absolute necessities are about the same in each shop although they may differ in size and quantity with the shop, depending upon the extent and type of work to be accomplished in it.

A brief survey of what it takes to conduct the average molding shop should be ample indication of the thought and care, as well as the money, that goes into the most conservative plant. Aside from the presses (covered in another article) we will confine our consideration to auxiliary factors and accessories that enter into the efficient operation of molding shops.

High pressure hydro-pneumatic accumulator system. (Photo courtesy The Watson-Stillman Co.)



## Material—storage and preparation

Molding powder comes from material suppliers in huge drums. First of all, then, a molder needs a storage warehouse for powder and a system of storage that works efficiently. For example, an average shop has at least 100,000 pounds or more of material in the plant all the time, probably made up of sixty different types, kinds and colors, which must be segregated and at the same time immediately available for use. Most shops have racks for classification of these materials and incidentally, arrangements must be made so that the material is used in the same order it comes in. If a few drums are allowed to remain in the background and new deliveries are piled in front of it, the old material might not produce 100 percent results when it is finally dragged from its hiding place.

Theoretically, the powder is ready to use as it is received. Actually, it is broken down into convenient amounts for molding, which may be a matter of weighing into receptacles of a proper size, or compressing the powder into pills or briquettes. This is accomplished by putting it through a pilling machine which is an oversized edition of the type of machine used in making life savers or aspirin tablets, with the addition of special features such as pressure and larger filling spaces.

There are two distinct types of preforming machines and most shops have at least one of each—a single stroke press and a rotary press. The single punch press is used for making odd shapes and sizes in nominal quantities. The rotary preforming machine goes into action where real production of identical tablets is required. In some instances, when a large number of similar pills is being made, overhead handling equipment becomes important. A full drum of material is fitted with a hopper head, inverted and raised into position directly over the material hopper on the machine. Using this equipment, a full drum of material can be preformed without frequent refilling of the hopper on the machine with an attendant elimination of dust caused by scooping the powder into the hopper.

The preforming presses must be isolated from the remainder of the shop and from each other because of a certain amount of uncontrollable dust. A complete dust collecting system must be attached to at least three spots on the pill machines and connected to a dust disposal unit to ensure freedom from dirt.

One of the requirements in the pilling room is a sensitive scale that will measure as little as  $\frac{1}{100}$  of a gram so that a constant check can be kept on the pills as they roll out. A simple balance type of scale takes care of this

operation. A small hammer mill or similar contrivance is invaluable for grinding waste, or imperfect pills, making it possible to reclaim material that might otherwise be of no use. Also, adequate storage racks are essential in the preforming room for safe keeping of idle preforming dies or tools.

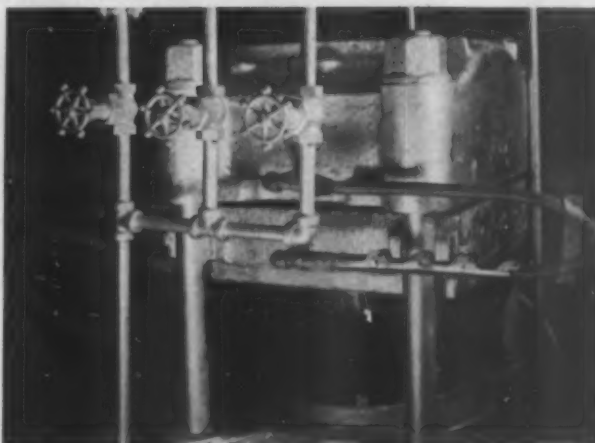
Upon occasion it is necessary to use powder rather than pills, and the powder must be weighed as accurately as the preforms. If but a few shots are to be weighed, it is generally done by hand on a simple balance scale, either in the powder room or at the molding press. If, however, a quantity of weights of exactly the same amount is needed, it becomes necessary to use a machine for economical production. This machine is similar to the single punch pilling press except that instead of providing a heavy impact to form the pill, a slot opens at the bottom through which the material drops into an appropriate receptacle. This receptacle must be constructed so as to stand on its own base. An ordinary paper drinking cup is often sufficient or if larger pieces are to be molded, larger containers are used such as boxes or molded pieces that have been rejected.

An adequate exhaust hood to remove dust should be placed over the powder hopper of each measuring machine, and a vacuum cleaner of the type used to clean furnaces, equipped with a long hose and nozzle, is helpful for cleaning the machines as well as the walls and floor of the room. Naturally, individual booths are preferable for each material measuring press to prevent the inclusion of any foreign particles or specks of color from an adjacent machine.

Preforms drop from the tableting machine into tote boxes or drums and are delivered to the presses in large fiber boxes. Sometimes, overhead conveyors carry buckets or pails to workmen at the presses; sometimes trucks trundle here and there with loads of pills or powder, but in each shop, an appropriate system of delivery of material to the workmen must be devised to ensure uninterrupted schedules.

### Heat and pressure equipment

The transforming of either preforms or powder into finished molded objects, whether large or small, requires tremendous heat and pressure, and the harnessing and control of these two elements through the molding presses are of foremost importance in any molding shop. To begin with, a molding plant must have installed a surprisingly large steam boiler of a type to give a steady supply of steam. These boilers may be operated by gas, oil or coal depending upon the location of the plant and the most economical fuel to be secured under individual conditions. When gas or oil is used, the firing method is automatically controlled. When the fuel used is coal, it is desirable to equip the boilers with automatic stokers, for with hand firing there is likely to be variation in pressure and consequent variation of temperature at the presses. Each time the door of the boiler is opened to put in fuel, the temperature goes down. With the automatic stoker, the coal is fed into a huge hopper, pushed automatically into the fire box and burned at a



Top—High and low pressure, three stem operating valve. Center—Leather packings—cup, "U" and flange. (Photos courtesy The Watson-Stillman Co.) Bottom—Self-drain support with flexible hose and couplings conducting steam on platen press. Support and press shown in closed position illustrating the manner in which perfect drainage is assured. (Photo courtesy Chicago Metal Hose Corp.)

definite rate of speed, ensuring continuous, even heat at each press so equipped.

Each press unit should be equipped with its own steam trap, usually of the lift type which forces the condensate to overhead lines where it flows by gravity back to an open feed water heater. By having individual traps it is quite simple to connect small steam reducing valves to a press that may require a reduced temperature while running urea or colored phenolic molding material, while its neighbor is operating at standard temperature. Several small, efficient steam reducers which can quickly be tied into the press line, are standard equipment in the molding room. The steam (Continued on page 238)



**HPM**

**HYDRO-POWER PLASTIC**

## **INJECTION MOLDING PRESS**

See this new 1938 H-P-M Injection Molding Press in action—at the 16th Exposition of Chemical Industries—Grand Central Palace—New York City—the week of December Sixth. Learn at first hand all of the important features exclusive with this H-P-M machine. Call at Booth 418, third floor.



*Injection*

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With the rapid development of the injection molding press by H-P-M... injection molding has become universally recognized as a decided economy factor in modern plastic production. It has made possible a broader application of plastics to modern product design; higher production through increased speed of operation; decided economies in the molding of products now produced by conventional methods; an attractive saving in die expense.

All of these advantages... experiences gained as the pioneer in injection molding development in this country... are available to the modern molder through H-P-M's latest contribution to the plastic industry—the 1938 H-P-M Hydro-Power Plastic Injection Molding Press.

This modern press performs every function of the injection molding cycle with maximum efficiency and dependability. The operation includes: clamping the mold halves under direct hydraulic pressure; feeding the thermo-plastic material in original form in measured quantities; heating the material to plasticity; contacting the plastic material chamber outlet with the mold inlet; extruding the plastic material from the heating chamber into the mold cavities where the plastic chills and sets; opening the mold; and injecting the finished articles.

All of these events are co-ordinated through the H-P-M automatic control. Every H-P-M feature is protected with U. S. Patents or applications.

The new H-P-M Plastic Injection Molding Press is built in three sizes—to meet every molder's requirements.

Write for Bulletin 3708-MP, which describes in detail its many advanced and exclusive features of design, construction and operation.

THE HYDRAULIC PRESS MFG. COMPANY • MOUNT GILEAD, OHIO

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*Molding Presses*

# FLEXIBLE METAL TUBING

by A. F. JOHNSON and L. S. RAISCH

RECENT RAPID PROGRESS IN PLATEN PRESS improvement for all types of plastic molding operations is reflected in the development and adoption of one piece flexible metal hose and coupling units for steam and cold water connections. With production departments demanding constant operation, molders and maintenance engineers are today looking on these jointless units as necessary standard equipment.

The units consist of corrugated, seamless, alloy-bronze tubing, covered with a wire braid and coupled with heat-proof, non-pack couplings. The fact that the units have no packing in either couplings or tubing means a reduction in stand-by time ordinarily allotted to tightening and repacking other types of fittings. Such a time saving obviously benefits production cost records and reduces the overhead charges made against maintenance labor. Non-leaking flexible metal hose connections are also a guarantee of constant steam heat and pressure, thereby ensuring constant production cycles.

In addition to these benefits from flexible metal hose, the last year has seen progress and development in the use of self-drain supports for hose connections as a further aid to the production cycle. The supports (Fig. 1) are for use where long lengths of tubing are employed and engineers desire to reduce the possibility of water pockets forming in the extended loop.

Preliminary to a discussion of the development of the supports is the necessity for thoroughly describing the use of flexible metal hose on platen presses. The tube itself is formed from a special high tensile alloy bronze strip which is welded into a straight tubular form by a butt welding process. Through this butt welding process of tube formation the finished tube wall has the best

possible molecular structure because it is formed from precision rolled strip.

The straight tube then passes through a forming machine where the annular convolutions are spun into the welded tube by means of a "50-50 principle" of corrugated tube construction. Under this principle the metal is worked only half as much as in other forming processes thus avoiding any weakening or thinning of tube walls at the trough or crest of the corrugation. Approximately four feet of straight welded tubing is required to produce one foot of finished corrugated flexible tubing. A bronze braid exterior is then applied to give maximum resistance to internal pressures and prevent elongation, creating a "balanced strength" unit. In cases where it is desirable to minimize condensation due to exposed cooling surfaces, an asbestos braided covering may be applied over the entire length of the unit.

The ability of corrugated seamless flexible metal hose to meet bends in platen press work is shown by the following scale of tube size and bending diameters:

| Tube Size | Inside Diameter Bend |
|-----------|----------------------|
| 1/4 in.   | 5 1/2 in.            |
| 3/8 in.   | 9 1/2 in.            |
| 1/2 in.   | 11 in.               |
| 3/4 in.   | 14 in.               |
| 1 in.     | 19 in.               |

The efficiency of the tube is duplicated in the coupling (Fig. 2). It is quickly attached or removed without the aid of special tools and without the use of either packing or solder. A flanged, tapered, split sleeve, which projects back under the braid of (Continued on page 274)

FIG. 1

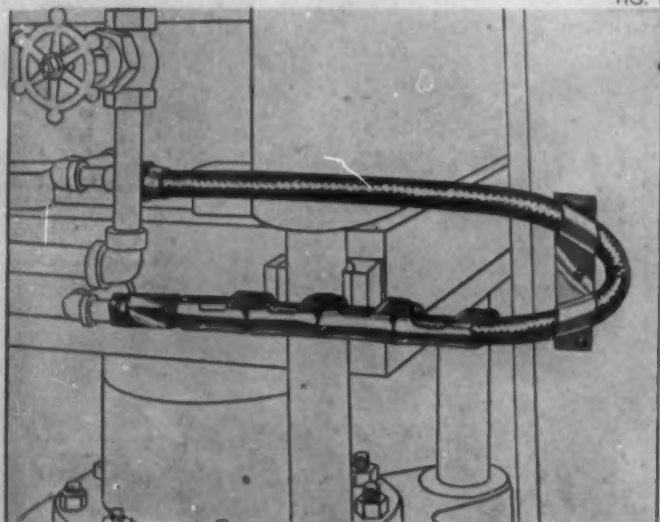
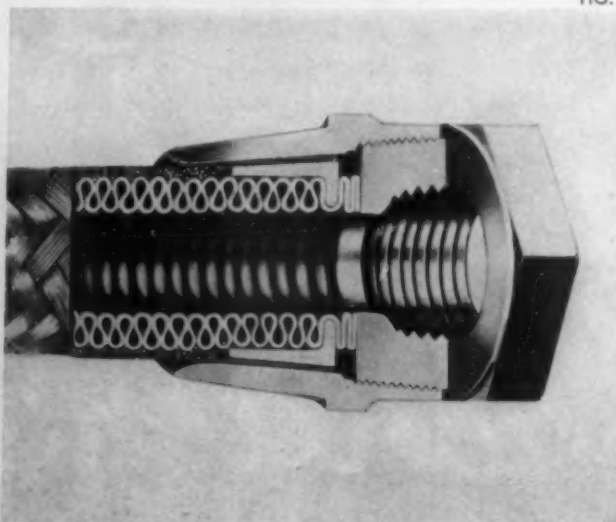


FIG. 2





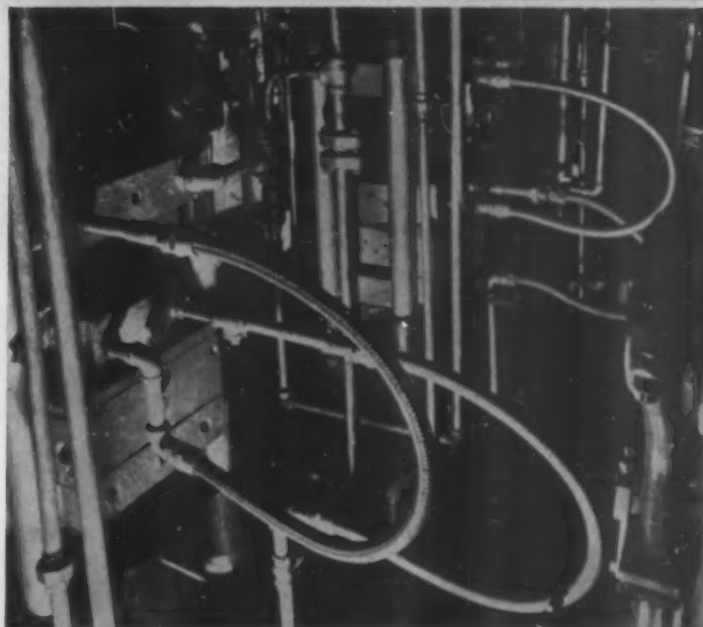
## MODERN DEVELOPMENTS

Help To Insure Constant Production Cycle On Platen Presses

### REX-WELD FLEXIBLE METAL HOSE

#### Developed Specifically For Platen Press Application

● REX-WELD, the jointless non-pack flexible metal hose is establishing super-service records on platen presses everywhere. New and exclusive process of one-piece, jointless, balanced strength construction provides maximum strength with minimum weight and cost—steam-tight, water-tight, pressure-tight super service flexible connections that maintain constant tightness under alternate heat and cold and help to insure constant production cycle. No packing, no leaking, no tightening. Fabricated in strip from special alloy bronze, REX-WELD is highly resistant to fatigue under vibration and bending stresses.



### REX SELF-DRAIN SUPPORTS

#### Improved Design Retards Condensate in Long-Length Steam Connections

● As a further aid to constant production cycles, Chicago Metal Hose Corporation engineers developed Rex Self-Drain Supports—providing a practical solution to the problem of condensate forming in the extended loop on horizontal long-length connections. This improved type of support prevents the hose from sagging below the horizontal—successfully eliminating the water pocket in which condensate might accumulate, resulting in temperature decrease. Rex Self-Drain Supports permit free movement of the unit at all times and controls the flexing of the hose without unnecessary strain.



View of Rex Self-Drain Support when platen is closed

PATENT APPLIED FOR

REX-TITE COUPLINGS offer new economies—removable, easily attached and reattached without packing or solder. Metal-to-metal seat forms seal impervious to temperature changes and leakage. New book gives full information on Rex-Weld Flexible Metal Hose, Rex Self Drain Supports and Rex-Tite Couplings. Send for your copy today.

## CHICAGO METAL HOSE CORPORATION

Formerly Chicago Tubing & Braiding Co. (Established 1902)

MAYWOOD, ILLINOIS

(Chicago Suburb)

# HYDRAULIC CONTROLS

by L. R. TWYMAN

MYSTERIOUS ONLY TO THE EVER DECREASING number who have not yet been initiated, the subject of hydraulic control systems is becoming really interesting to many who are adopting hydraulic operation for their control requirements. During recent years rapid and important changes have been made in general hydraulic control methods, as well as in improvements in the design of available pumping and valving equipment. These changes, coupled with the advent of the injection type molding machine and the modern self-contained hydraulic press, bring up entirely new problems for consideration when purchasing and during maintenance of molding machinery of these types. Many buyers and users of molding machinery are therefore expressing their interest in becoming better acquainted with the simple fundamentals of the newer types of control systems, the standardized hydraulic equipment now available for use in these systems, and the more important pointers on maintenance during service.

In one form or another hydraulic systems have long been the accepted means for applying the "big push" needed for manufacturing plastic molded products. Originally, as practically all hydraulic presses were designed to use water as the working fluid, the first designs accepted by the plastic molding industry accordingly used water for their operation. More recently oil has become the favored fluid medium with a large number of press designers, and their new high speed oil presses may now be seen doing all manner of both light and heavy press work in diversified industries. Molding plants will be found to have a goodly share of these, as the self-contained oil operated press seemingly meets the molding industry's needs ideally and has gained genuine approval for their type of work.

It therefore followed that the subsequent development of the injection molding machine should include the use of oil hydraulic control. This was especially logical since this type of control had met with almost universal acceptance in the die-casting industry, where the mechanical design problems involved were similar.

As the merits of hydraulic design versus other designs have been widely publicized, emphasis being placed upon flexibility, low cost maintenance, proper pressure control, and ease of automatic cycle operation, a discussion of these merits is being omitted here for the sake of brevity. Also, the consideration often arises of the advantages possessed by the self-contained design of press, having its own pumps, as compared with those designs which must be supplied by a pressure accumulator system. This too can be treated as a subject in itself, and is thus omitted. It has been noted, however, that the in-

roduction of the low cost oil pump for high working pressures has been one of the major factors in influencing the increasing predominance of new users toward self-contained molding presses and molding machines designed to have their own pressure supply systems. While the advantages of self-contained designs are nearly always recognized, many times these advantages have been heretofore offset by prohibitive pump costs.

Our topic therefore may, for sake of current interest, narrow to the subject of oil hydraulic pumps and control valves for the self-contained molding press and injection machine. Inasmuch as the manufacture of pumps and valves of this type is a very specialized industry, requiring engineering, research, development and production methods specifically related to the high pressure oil hydraulic field only, consideration is being given here to commercially available products rather than theoretical designs. These products have become standardized and flexible as to application to a degree such that they may be used to obtain all manner of results on automatic machinery, machine tools and presses. This means that the user in each industry benefits from developments made in other fields, and that the hydraulic units may be considered an accessory as are electrical controls considered in like manner.

Obviously, trouble-free operation of the hydraulic system is a most important link in production, and as a result, simplicity, accessibility and ease of maintenance throughout the entire system are major points of interest to the user. These three points cannot be emphasized too strongly. In addition, it is of course necessary to consider initial cost, long life, quietness of operation, ease of obtaining interchangeable repair parts and other similar items the comparison of which are important to all other mechanical equipment as well as to the hydraulic units.

When thinking in a general way about hydraulic control equipment, it is easiest usually to divide the subject into the following classifications: (a) Pumps; (b) Pressure Controls; (c) Volume Controls; (d) Directional Controls.

Within each of the above classifications a great many standardized hydraulic devices have been developed. Combining various units of one classification with various units of another classification makes possible an infinite variety of so-called hydraulic circuits, with which may be accomplished virtually any sequence of semi-automatic or fully automatic operations. This flexibility is in itself one of the fundamental advantages of the use of hydraulics for control. Many sizes of each model of pump and control valve should be available in a complete line of standardized products, as volume and

pressure requirements must both be considered when meeting the requirements of each specific installation.

Pumps for high pressure oil service may be divided into two general classifications. Those of the first classification are termed "constant delivery" type pumps, and are of such design that they will always deliver a given amount of oil, depending upon their size, when driven at a given constant number of revolutions per minute by the drive motor. Thus a pump rated to deliver 18 g.p.m. at zero pressure when driven at 1,200 r.p.m. will deliver nearly 18 g.p.m. at a pressure of 100 lbs. per square inch, at 500 lbs. per square inch or at 1,000 lbs. per square inch, provided it has good volumetric efficiency over this pressure range.

The term "volumetric efficiency" sounds somewhat impressive to some, and in fact it is an important thing to bear in mind. If an 18 g.p.m. constant delivery type pump delivers its rated amount at zero pressure but drops to a rate of, say, 9 g.p.m. at 1,000 lbs. per square inch, then its volumetric efficiency has dropped to 50 percent, under this latter condition. A pump of the same size which drops to a volumetric efficiency of 75 percent under the same conditions of r.p.m., oil viscosity, temperature and pressure, deserves to rate as being twice as good in this respect as the first pump. The reason is that there is only half the volumetric slippage present, and slippage represents a loss of power.

Constant delivery pumps for the most part may be designed simply, with few moving parts. They are therefore inherently less expensive and easier to maintain than other more complicated types. Three designs are most widely used, in one variation or another—(a) gear type, (b) vane type and (c) piston type. Much might be said concerning each design, but, put in few words, it can be said that gear pumps as a general rule are limited to maximum, continuous duty, efficient working pressures of approximately 250 lbs. per square inch, although having the minimum number of working parts; the vane type pump can be designed for pressures considerably in excess of 1,000 lbs. per square inch and has but few moving parts; the piston type pump can be designed for practically any commercially usable pressures, but has as many moving parts usually as the more complicated variable delivery type of pump.

Now, to consider the application to plastic molding problems, it is found that the constant delivery pump used singly is limited in its scope. Reason for this is the fact that the requirements for most of the hydraulic systems used for molding include a rapid closing and opening movement which needs but relatively low operating pressure, while high pressure is required at a considerably slower rate of movement, or for a holding period, during another part of the cycle. A constant delivery pump of large enough volume to give the rapid movements at low pressure would require too much power when the high pressure portion of the working cycle is encountered, due to the fact that the excess volume would have to "spill over" the pressure control valve of the system at the high pressure. This condition is not at all serious on the smaller applications, and as a result these applications

enjoy the low cost simplicity which is the advantage of the constant delivery type pump. Larger installations require another method of treatment to gain these advantages however, this method using two constant delivery pumps in place of a single pump.

Suppose we have an operating requirement as just outlined, i.e., (a) large oil volume needed at relatively low pressure for fast opening and closing movements, and (b) small oil volume needed at relatively high pressure for final "push-up and hold" action. Fig. 1 shows two schematic flow diagrams representing the method used to meet the hydraulic requirements of this type of cycle when constant delivery pumps are employed. It will be noted that two pumps are mounted end to end in a common housing and driven by a single shaft. Usually one pump is of considerably larger size than the other, and thus capable of delivering more volume than the other. Directly attached to one side of the double pump housing is a three unit "combination" valve, while attached to the opposite side is a simple intake manifold for supplying oil to both pumps from a single intake pipe. The whole makes an integral assembly which is termed a "double pump and combination valve assembly." Fig. 2 is a photograph of a commercial design of such an assembly, using balanced vane type constant delivery pumps.

Referring in greater detail to Fig. 1, it should be noted that both the small and the large volume pumps indicated are intended to represent (*Continued on page 270*)

(All photos courtesy Vickers, Inc.)

FIG. 1

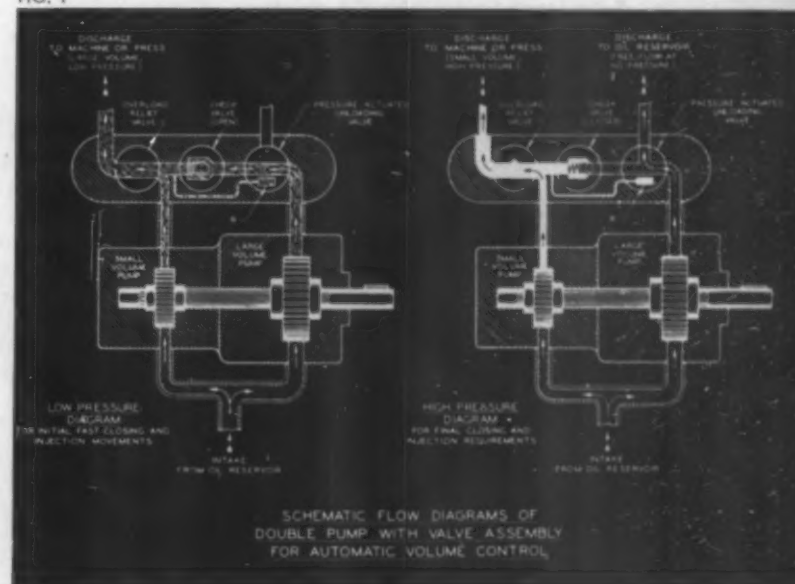


FIG. 2



# The *Improved* REED-PRENTICE

## No. 10A PLASTIC INJECTION

### NEW CONSTRUCTION FEATURES INCLUDE:

1. Stationary die plate increased to  $4\frac{7}{8}$ " thickness cut from solid steel plate.
2. Steel movable die plate increased 1" in thickness now  $4\frac{1}{2}$ ". Improved ribbing of die plate and longer bearing on the tie bars,  $10\frac{1}{4}$ ". Plate equipped with bronze bushings with lubrication facilities.
3. Larger capacity pump furnished giving 120" per minute *continuous* material plunger speed. Pressure on material 2000 to 21,000 pounds per square inch.
4. Standard equipment now includes automatic indicating control pyrometer.
5. Many minor changes including improved timing units and location of timers, push button and dials for easier operation. Shut off valves for oil gauges furnished. Valves will be closed and opened only when checking pressure.
6. Relocation and redesign of push button station with selector switch and dials for single cycle or automatic operation, mounted higher on panel control.
7. Pilot valve levers to have locking mechanism eliminating danger of accidentally starting machine.
8. Machine will weigh approximately 10,000 pounds.
9. Machine requires 15 HP 1200 RPM on 60 cycle, 1000 RPM on 50 cycle, drive motor and control.
10. Improved heating unit giving greater capacity. Unit is longer, same diameter, and the torpedo has circular holes rather than the square slots eliminating the trouble of light colors lodging in the corners and burning. Independent rheostat control for the front and rear elements by two rheostats. In addition we are now furnishing a heating unit on the nozzle that can be shut off after machine is functioning properly eliminating trouble in the past of materials solidifying in the nozzle.
11. Timing controls with dials have been improved with larger capacity rotors in the timers for quicker operation. Wiring for the panel and the complete electrical cycle has been simplified.
12. We are now furnishing a Nitraloy Material Plunger and a Nitraloy Sleeve in the plunger cylinder eliminating the chance of scoring. Nitraloy, as you know, is glass hard and we consider it superior to chrome plating.
13. We are now furnishing a sheet metal guard to cover the opening between the "C" shaped casting and the die plate nearest the nozzle.
14. The larger capacity pump we are now furnishing only requires 15 HP for a period of 2 seconds during the injection cycle. For the rest of the complete machine cycle only  $7\frac{1}{2}$  HP is necessary to operate the pump. The extra power required for those 2 seconds is the only reason for using the 15 HP motor.

Seventeen Reed-Prentice #10 Injection Molding Machines awaiting delivery on our assembly floor to one customer. Purchased and now in use by leading molders throughout the world. These machines have an enviable record for performance proven by many repeat orders.



# full automatic hydraulic MOLDING MACHINE

So phenomenal has been the success of the Reed-Prentice No. 10 Injection Molding Machine that . . . on a straight "business" basis . . . few changes or improvements were called for.

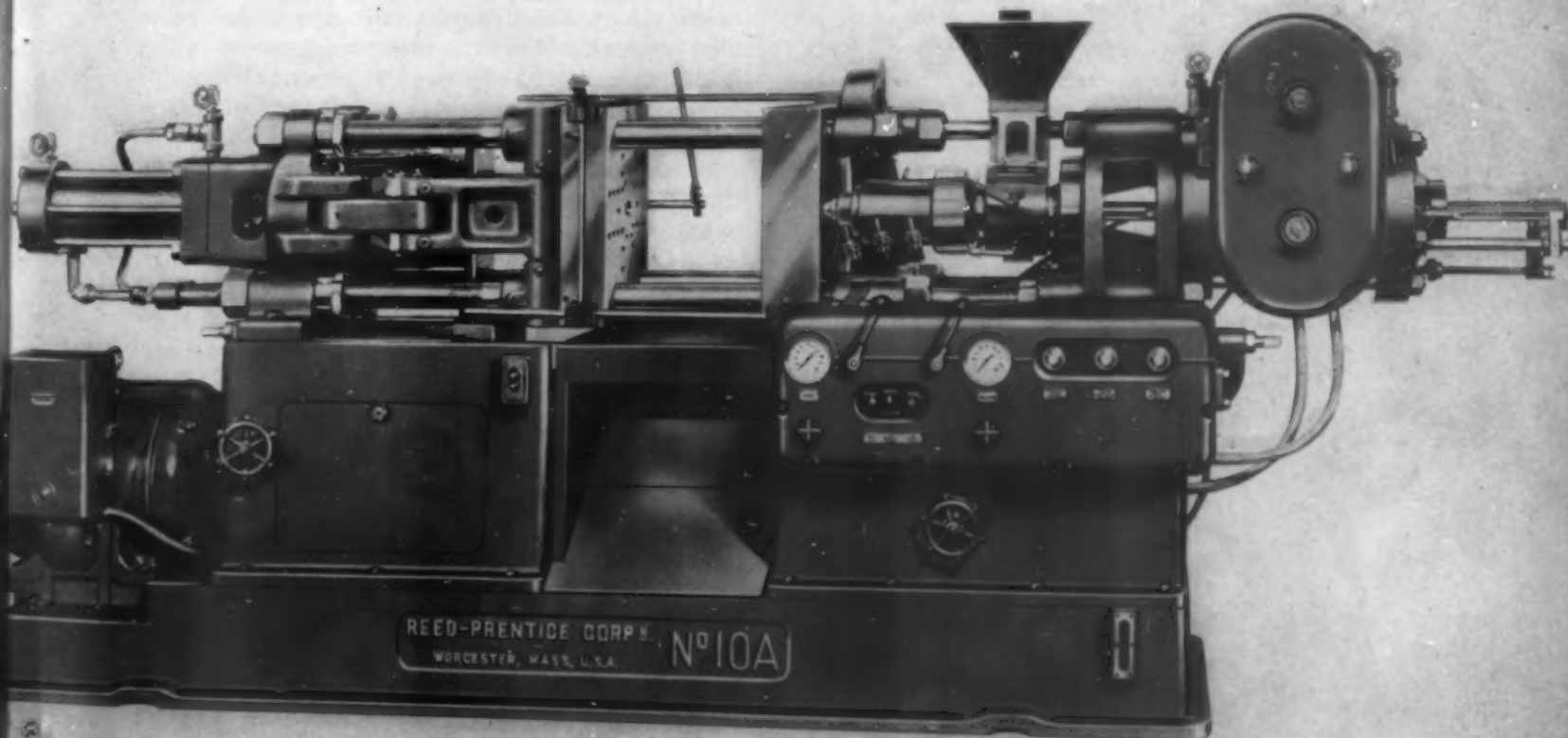
But Reed-Prentice engineers have devised a series of changes and improvements that make the new No. 10A an even greater, more useful, more productive machine . . . definitely the finest ever produced for injection molding.

New, heavier dieplates! Larger capacity pump! Relocated timer and push buttons and dials for easier operation! Additional safety features! Improved heating units!

If you are considering injection molding . . . investigate this new, improved Reed-Prentice No. 10A now. Write for full details.

## Model No. 10A General Specifications

Capacity of Hopper Slide—7 c/in. Gran.  
Material, 2 1/4 c/in. moulded, 2 oz.  
moulded  
Estimated shots per hour—300 to 400,  
varying with type of part, 500 c/in.  
moulded material per hour, 24 lbs. per  
hour  
Pressure per sq. in. on material—2000 to  
21,000 lbs.  
Maximum injection area of mould ca-  
pacity—24 sq. in.  
Diameter of plunger—1 1/4"  
Stroke—7"  
Speed of Plunger Continuous 120 in. per  
minute.  
Approximate power con-  
sumption for heating  
unit.....0.5 to 1.5 KWH  
Size of die plates.....18" X 20"  
Capacity of feed hopper.....20 lbs.  
Space between bars.....12" X 12"  
Die Opening.....8"  
Maximum die space.....18"  
Minimum die space.....6 1/2"  
Diameter of tie bars.....2 1/2"  
Oil pressure.....1000 lbs. sq. in.  
Motor recommended.....15 HP 1200 RPM  
Floor Space.....144" X 40"  
Weight, approximately,  
exclusive drive motor, 10,000 lbs.



### AGENTS

NEFF KOHLBUSCH & BISSELL, INC.  
2400 West Madison Street, Chicago, Ill.  
L. H. MESKER  
Hotel Hollenden, Cleveland, Ohio  
STERLING-FRENCH MACHINERY CO.  
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**REED-PRENTICE CORP.**  
WORCESTER MASS. U.S.A.  
NEW YORK OFFICE - 75 WEST STREET

# HEAT FOR MOLDING PLASTIC MATERIALS

by J. EARL SIMONDS

A STEADY SUPPLY OF UNIFORM HEAT IS ONE OF the most important factors in the process of molding plastic materials which are divided into two general groups designated as thermosetting and thermoplastic. Thermosetting materials, which are compression molded, are softened by heat to a point where they will flow adequately under applied pressure to properly fill the mold cavity, and continued heat at proper temperature brings about complete polymerization of the resin content of the material, the polymerization being a chemical change which results in permanently hardening the molding material. The sole function of heat for the thermoplastic group, which may be formed either by injection or compression molding methods, is to soften the material sufficiently so that applied pressure forces it into all parts of the mold cavity, after which the mold must be chilled to set or harden the material.

The necessary heat for these functions in plastic molding plants may be supplied by any one of three methods—steam, electricity or gas, the choice of method depending largely upon relative convenience in operation and relative costs as they pertain to each individual plant.

## Compression molding by steam heat

First in order of popularity is steam heating. High pressure saturated steam, generally accepted as more satisfactory than either low pressure or super-heated steam, is piped into channels running through the press platens (Fig. 1). Usually these same channels are also piped to a cold water line for the introduction of water for cooling purposes and both the water and steam lines have individual check valves to control alternate heating or chilling as desired. Oftentimes steam is introduced into the mold as well as the platens, through the same

general arrangement of channeling and where a multi-cavity mold is used, the channels must be placed so that heat distribution to each cavity is uniform. Small molded pieces of thin section and which are comparatively shallow do not require a channeled mold. In such instances, the mold draws its heat directly from the heated, channeled platen on which it is mounted.

The high-pressure boiler required to generate steam varies in capacity or horsepower with the number of presses and the aggregate of heated areas and masses in the molding plant. Miniature boilers, either gas or coal-fired are available for heating where but a few presses or individual presses are used. In the average molding plant, however, it is customary to have a centralized boiler unit for distribution of steam to all molding presses. The small individual boiler unit may cost a few hundred dollars, whereas a large centralized boiler unit may cost many thousands of dollars.

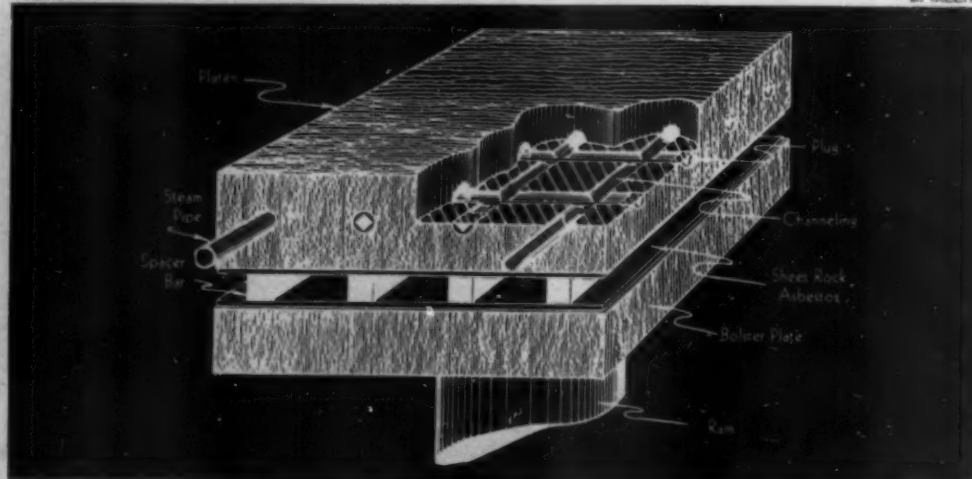
At least one platen of any compression molding press moves toward a fixed or stationary platen when pressure is applied, which necessitates the installation of a flexible conveyor of steam to the press. This flexibility or movability is accomplished through the use of coiled copper tubing, flexible-woven tubing, or swivel couplings or joints. Where copper or flexible-woven tubing is used, care must be exercised to eliminate all possible torsional stresses in order that maintenance annoyances and expenses may be minimized.

Steam pressure, and hence the temperature, is regulated through a reducing valve which may be set to control to any desired pressure within the boiler pressure range. As the latent heat of the steam is transferred through condensation, the condensate must be properly drained or expelled from the platen and mold, and steam traps

(Continued on page 234)

FIG. 1

BAKELITE



# Modern

## PRESSES FOR THE MODERN MOLDER

● Modern production requirements call for modern machines and methods. The rapid growth of the plastic molding industry has made it necessary to redesign conventional plastic molding presses to conform to the new trend of "switch to plastics wherever possible."

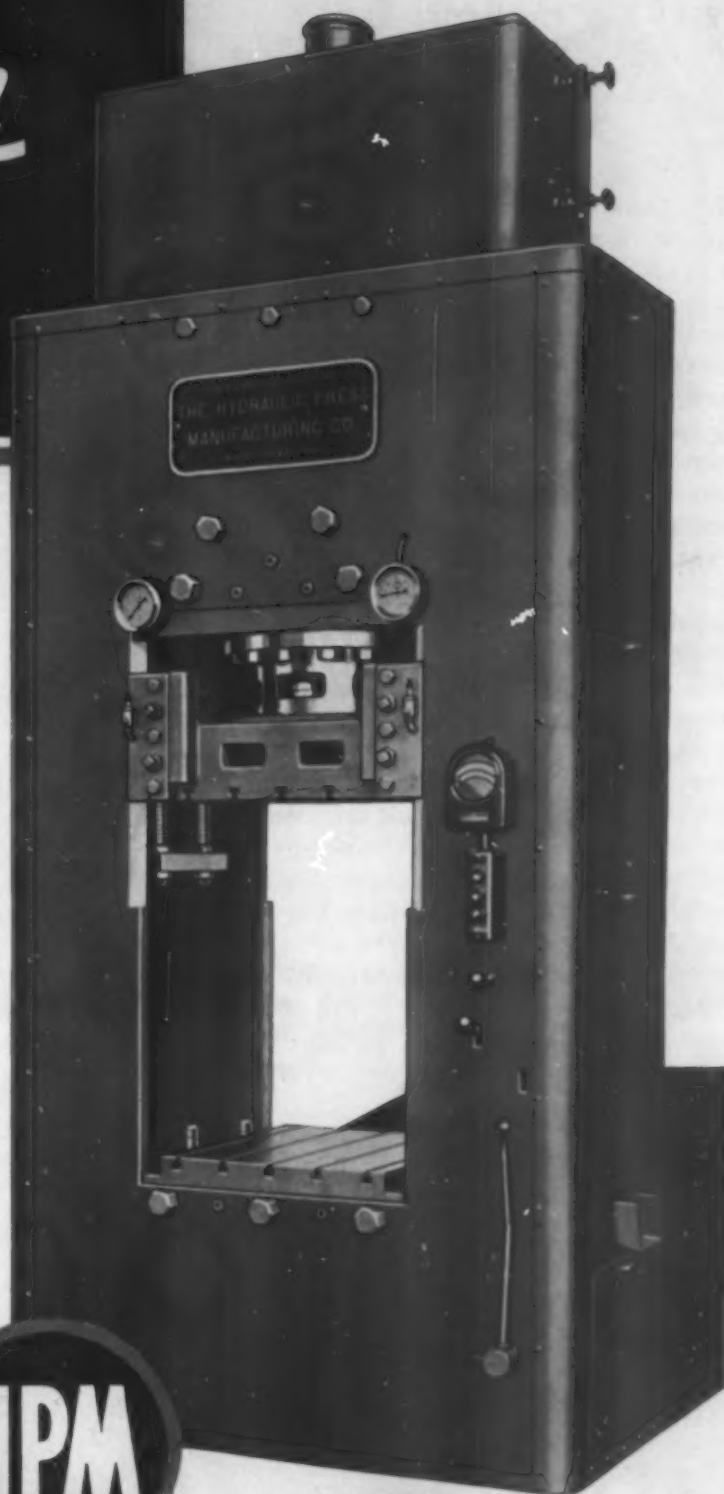
The New H-P-M Smooth-Line Plastic Molding Press is H-P-M's contribution to this modern trend. It is a neat, compact press for maximum production and dependable performance. It requires a minimum of floor space as it is completely self-contained—with all operating equipment including the exclusive H-P-M 4R Radial Pump mounted on the heavy steel plate press frame.

H-P-M Smooth-Line performance includes rapid ram advance and return—reduced pressing speed—variable ram speed adjustment—Independent regulation of rate of pressure application—automatic cycle control.

Modernize with H-P-M Smooth-Line Plastic Molding Presses.

Write for Bulletin 3709-MP describing H-P-M Smooth-Line Presses in detail.

**THE HYDRAULIC PRESS MFG. CO.**  
MOUNT GILEAD, OHIO, U. S. A.



**HPM**

# Smooth Line

## PLASTIC MOLDING PRESSES

# FINISHING PLASTIC SURFACES

by JOSEPH LUPO, JR.

IT IS DIFFICULT TO DETERMINE WHEN, WHERE and how the art of polishing and finishing material surfaces originated, but the genesis of this important phase of production can definitely be credited to nature, which not only supplies the idea but demonstrates simple methods of accomplishment as well. For example, pebbles in a brook are picked up by the rush of water, turned over and over and brushed by sand and fine gritty particles as they are carried along, eventually washing ashore or sinking to the bottom in some quiet spot, where they repose smooth, round and glittering. Huge rocks along the seaboard, constantly washed by waves and sand become rounded and smooth as glass. Obviously, the rolling action of water, containing sand which forms an abrasive, is responsible for the glossy surface and high luster of these pebbles and rocks. This work of nature, augmented and refined, has been adopted by man and commercialized to meet the requirements of many industries.

In early days, products made from ivory, bone, horn and even mother-of-pearl were rubbed by hand against a buff wheel operated by foot paddle power to finish the surface. At that time, grinding and polishing compounds were not well developed and after pieces were ground and polished by foot paddle power, they were hand rubbed to a high luster. This was usually done with a thick flannel cloth impregnated with heavy

polishing liquid. From this method can be traced the development of present day buff wheels and compounds.

As far back as 1870, inexpensive jewelry and small metal parts were tumbled in barrels containing fine sand and water which removed sharp edges. A few years later, ball burnishing barrels were introduced, and in these the pieces were given a suitable commercial polish. But it was not until forty or forty-five years ago that the sand and water method was adopted for tumbling genuine ivory, horn, bone and pyroxylin. The water-tight tumbling barrels originally used were round. Later, concerns in the pyroxylin industry shifted to square barrels. While the sand and water method of finishing adequately smoothed rough surfaces and edges, the pieces oftentimes became badly pitted. In an effort to overcome this condition, manufacturers of pyroxylin products began using—during the year 1920—pieces of cut felt, small pebbles and pyroxylin waste, together with water and pumice, to tumble their products. Although this was an improvement over previous practices, the finish obtained was not considered entirely satisfactory.

Continuous research and development work by concerns interested in polishing processes resulted about 1922 in the discovery that by using a dry tumbling barrel with dry compounds, pyroxylin products could be given a superior, lasting polish. This discovery represented the beginning of a new era (*Continued on page 228*)

1. Metal shell hard maple lined tumbler which holds the frictional heat essential for tumble polishing. 2. Mechanical sifters sift the work from the tumbling pegs and compounds used. (Photos courtesy Lupomatic Tumbling Machine Co. Inc.)



Below: The new Alnor Portable Pyrometer with Flexible Cable Connections gives extremely close readings of mold temperatures on its 6" mirror scale. The instrument uses our new ultra-rapid thermo-couple with a self-aligning tip.

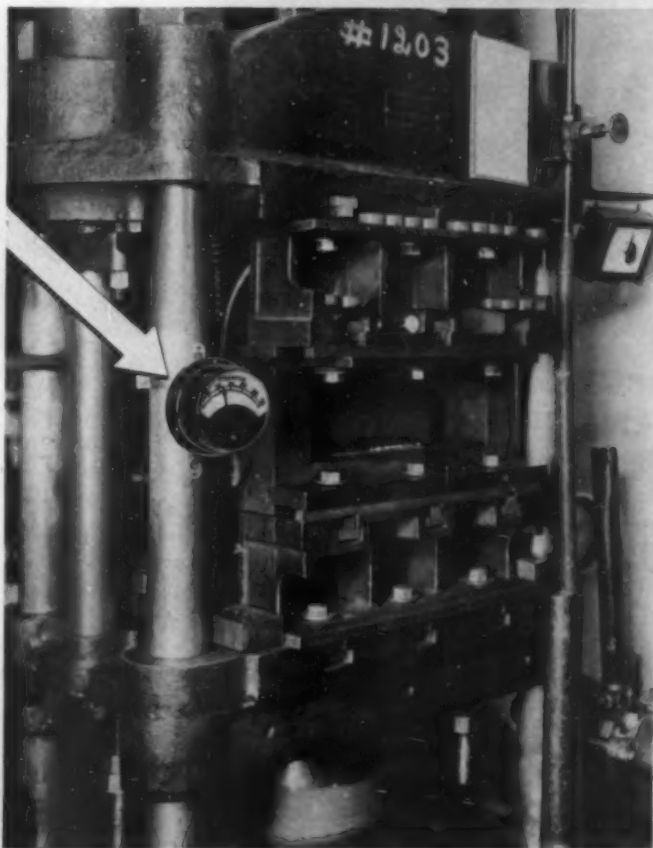


Courtesy  
Chicago  
Molded  
Products

ARE YOU  
TROUBLED WITH

Eggshell finishes  
Dogskin  
Orange peel  
Blistering  
Shrinkage  
Cracking  
Flux failure  
Pitt marks

THEN CHECK UP ON  
MOLD and PLATEN  
TEMPERATURES  
with an Alnor Pyrometer



At Left: A permanently mounted single point "Alnor" Pyrocon, installed on a press in the plant of the Chicago Molded Products Company, with the element inserted in the die providing continuous temperature readings. Note ease with which dial can be read by operator. Note, also, simplicity of instrument and method of installing.



Above: The "Alnor" Self contained Pyrocon portable. Specially designed for molding work, its light weight and easily read dial make for convenience for either the large or the small plant. The moderate price will quickly be returned in time and material saved. Hundreds now in use.

ILLINOIS TESTING  
LABORATORIES, Inc.

428 N. LaSalle Street

Chicago, Ill.

# ASSEMBLY JOBS—*similar to yours*

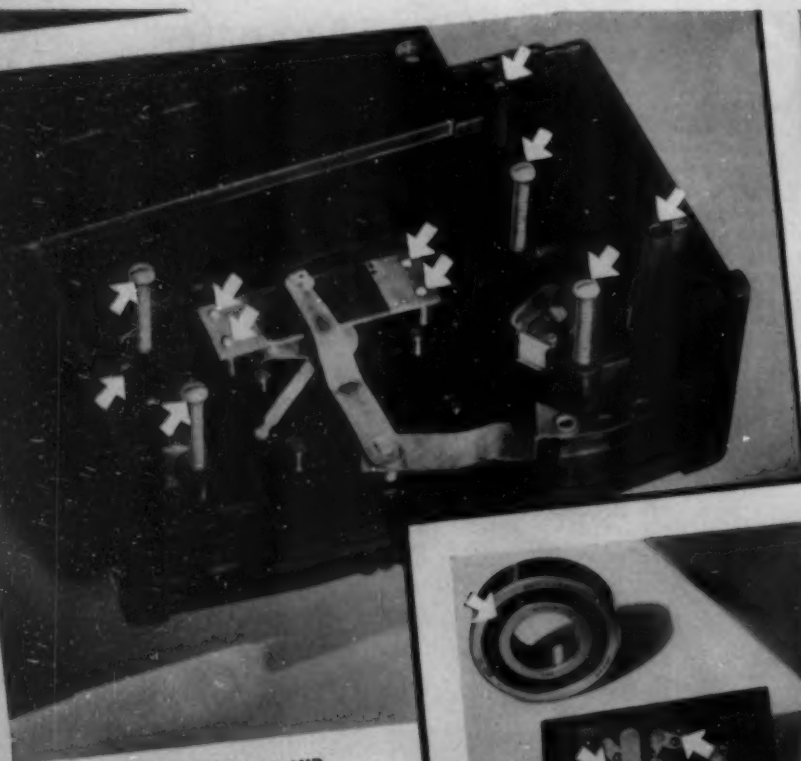
See how they are being done **BETTER...AT LOWER COST**  
with Parker-Kalon Self-tapping Screws

**Y**OUR PRODUCT may be far different but the chances are its assembly requirements are similar to those represented by the products shown here. Study these typical fastening jobs. See how Parker-Kalon Hardened Self-tapping Screws have been applied to speed-up molding and assembly work, reduce costs, simplify and improve product design, increase fastening security.

## Benefits Like These Are Common

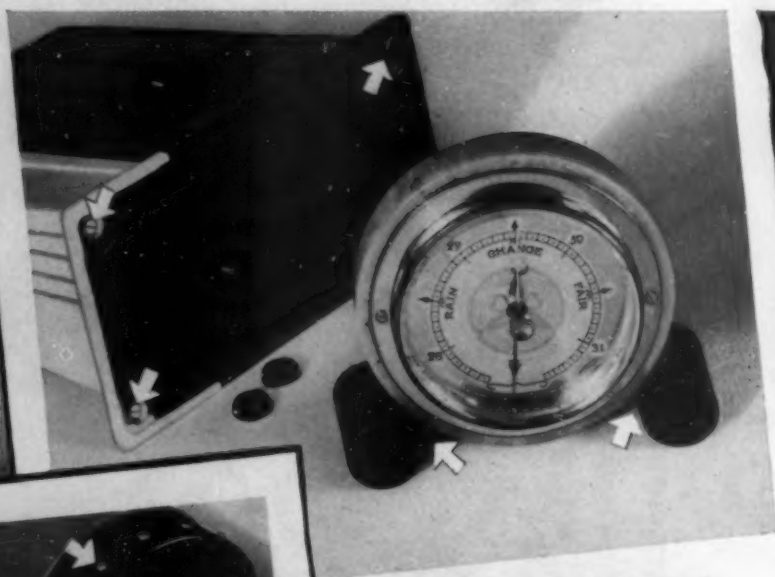
Here are examples of the reports that come from hundreds of assemblers and molders of plastics: "We stopped a 30 percent spoilage of parts due to

mistapping in bottomed holes of one-eighth inch depth, and now make assembly with less than half the time and labor" . . . "Self-tapping Screws saved quite a sum on cost of molds because inserts could be avoided, and they saved us much assembly labor and gave us stronger fastenings" . . . "The Screws save 2½ cents per unit by eliminating an insert formerly needed . . . "We figure a 25 percent saving on fastening contact springs to molded panels" . . . "Returns from faulty merchandise have been reduced" . . . "In molding we increased molding speed 30 percent and assembly rate 100 percent."



## MOUNTING ELECTRICAL AND MECHANICAL PARTS

To mount mechanical and electrical parts in this cautery instrument is a simple task since Type "Z" Hex Cap and Type "U" Self-tapping Screws were adopted. These Screws are ideal for such work because they are so easy to use in hard-to-get-at places, and because they eliminate inserts and difficult tapping.



## FEET ATTACHED TO PRODUCTS

A Type "Z" Self-tapping Screw threads through the molded case and engages in molded foot for the Barometer above. A unique application is seen in the Card Shuffler. A Type "Z" Screw holds a cone shaped washer onto which is pressed an undercut rubber foot. At the same time the Screw holds the metal base cover to the molded case.



## MECHANICAL AND DESIGN AIDS

Two halves of the Micarta ball retainers of the bearing are securely joined with headless Type "U" Self-tapping Screws. In the combination multiple pole switch and switch plate, Type "U" Screws serve a dual purpose. They act as contacts on the terminal block, as well as for fastening terminal posts to the molded part.

Effective cogs to engage a perforated metal driving belt are provided by Type "U" Screws in the molded end of the compression roller for a duplicating machine.



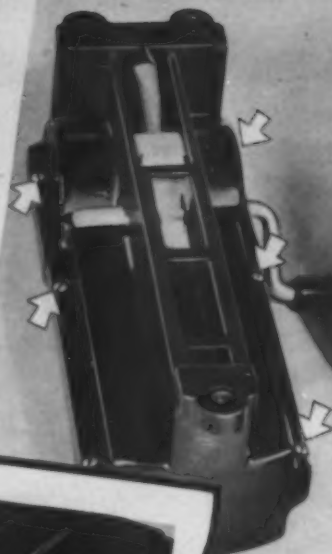
#### HINGE PINS AND ATTACHMENTS FOR BOXES

Six Type "U" Self-tapping Screws fasten the hinge securely to the molded box. In the other molded box two Type "U" Screws serve as hinge pins when driven through the cover into the bottom section.



#### CONTROL AND LIFT KNOBS SECURED

A molded lift knob is shown attached to an aluminum lid by a Type "U" Self-tapping Screw driven through the lid into the knob. This method is widely used because of its simplicity. Molded control knobs are secured to shafts in the surgical cautery instrument with Type "U" Screws.



#### HOUSING ASSEMBLIES

A metal cover is attached to the molded unit of the Thermostat control with Type "Z" Self-tapping Screws. The two molded sections of the soap dispenser are joined with six Type "Z" Screws. To fasten a metal back to the molded time clock case three Type "Z" Screws are used.

#### This Comparison Explains Why It Pays To Try These Screws

To assemble any of the common plastic materials with Parker-Kalon Hardened Self-tapping Screws you merely drive these Screws into a drilled or molded hole . . . a thread is formed in the material by the Screw as it goes in. It is simple and fast.

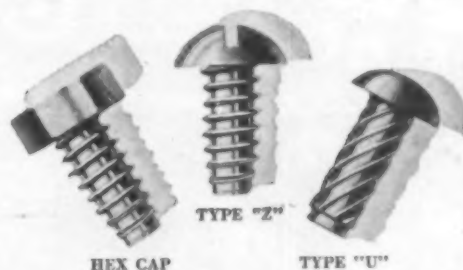
COMPARE with other methods: *To use threaded inserts and machine screws* means extra expense for inserts . . . often adds weight, takes up space, weakens assembly . . . slows-up and complicates molding. *To use machine screws in tapped holes* means an extra operation . . . weak threads that easily cross and tend to break down quickly . . . often involves breakage of taps . . . frequently results in rejects due to stripped and crossed threads and mis-tapped holes. *To force machine screws or wood screws into unthreaded holes* means poor assemblies and returned merchandise . . . difficult work . . . excessive rejects.

#### Have a Parker-Kalon Assembly Engineer Show Where You Can Use This Method

Find out what you could gain by using this simpler fastening method. Write us to have a Parker-Kalon

Assembly Engineer study your metal and plastic fastening jobs and point out all opportunities to make better fastenings at lower cost with Self-tapping Screws. Or, send a brief description of any assembly and we will furnish recommendations and free samples for a trial.

PARKER-KALON CORPORATION  
Dept. P, 190 Varick Street, New York, N. Y.



Type "Z" and Hex Cap are types of Parker-Kalon Self-tapping Screws which can be removed and reinserted repeatedly without impairing security. Type "U" is hammered in or forced in to make a permanent fastening. All types are suited to metal as well as plastic assembly. A wide range of sizes and various styles of head are available.

# PARKER-KALON *Modern* FASTENING DEVICES

SOLD ONLY THROUGH RECOGNIZED DISTRIBUTORS

## FINISHING PLASTIC SURFACES

(Continued from page 224) in finishing plastic surfaces and encouraged manufacturers to experiment with various polishing agents to obtain the desired results.

By 1924 the majority of products made of pyroxylin and casein were being tumbled in dry barrels. But in 1926, manufacturers of pyroxylin goods substituted an acetone dip which removed rough surfaces and imparted a polish to their products. This practically eliminated tumbling and in general served the purpose satisfactorily. Two years later a special chemical dip formula was imported from Germany for use with casein. This process effectually polished the casein but did not remove scratches nor produce a smooth surface. Therefore, after casein articles were blanked, it was necessary to tumble them in a dry pumice compound to remove any roughness on the surface or edges. Then they were dipped in the chemical solution and while still wet placed on a screen and allowed to dry in an oven. For better grades of casein products, a third operation was introduced. After being tumbled in the dry pumicing or scouring compound, they were semi-polished with a burnishing compound and then dipped and allowed to dry. The burnishing or semi-polishing operation ensured a high luster after dipping in the chemical, without the necessity of using a buff wheel. This method of finishing casein is still being used.

Experiments in dry tumbling of cast phenolic resins were conducted over a considerable period of time culminating in a method which ashed, burnished and polished

products made from this material to a fairly passable finish. Since the finish was simply a wax coating which did not endure, this process was considered usable only for inexpensive pieces. However, with the advent of cast resins into the button, novelty and jewelry trades, the need for adequate finishing methods which would produce a clear, lasting, waterproof luster became acute. The dry tumbling process was conceded to be efficient for the purpose and it remained only to perfect suitable compounds to meet different manufacturing requirements. With proper compounds, it was found that cast resins could be ashed, burnished and polished in a tumbling barrel to a luster equal to that of hand polishing.

There are many types of dry tumbling barrels but those most widely used today are the patented metal shell type which are hard maple lined. This tumbler (Fig. 1) is claimed to hold the frictional heat essential for tumble polishing. The size most commonly used for the general run of work is 30 in. in diameter, 36 in. long, octagon in shape, with two compartments. For large pieces, a 10 sided, 36 in. by 48 in. double compartment tumbler works most efficiently. These tumblers can be had fitted with mechanical sifters to sift the work from the tumbling pegs and compounds used. (Fig. 2.)

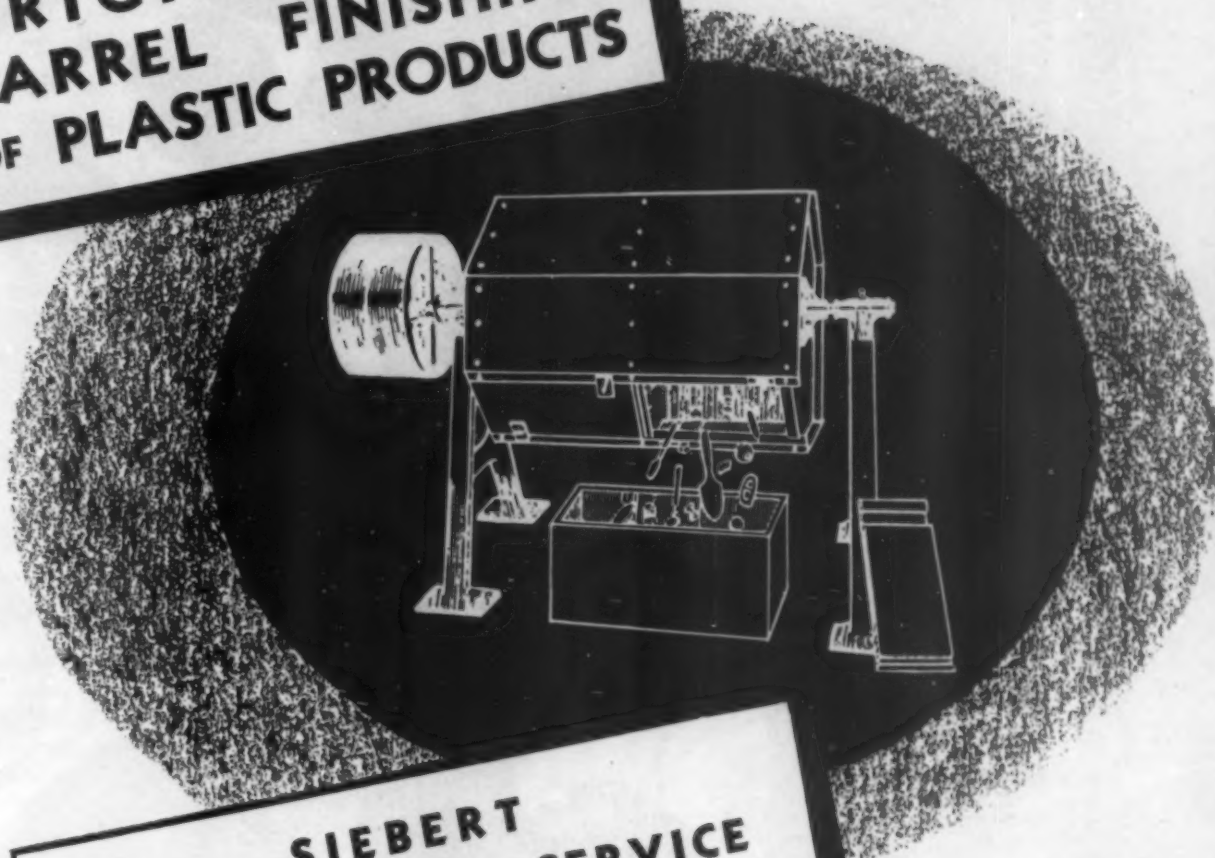
Originally, cast phenolic resins were tumbled without any great care. The speeds at which the tumblers revolved ranged from 35 to 45 RPM, which caused chipping and produced a badly pitted surface with a non-permanent finish. The process as refined produces a pitless surface, a permanent waterproof luster, and a finish which brings out the beauty of (Continued on page 232)

Three operation process: ashing, burnishing and lustering. The middle barrel cleans the work as it comes from the first operation before it is burnished



# SIEBERT - - -

**ORIGINATORS OF  
BARREL FINISHING  
OF PLASTIC PRODUCTS**



**SIEBERT  
CONSULTATIVE SERVICE**

on your finishing problems is available at no cost to you.  
Write us your problem or send for our detailed booklet.

Pioneers in the mass barrel finishing of plastics, Siebert has recently announced newly improved and exclusive processes to provide superior finishes at lower costs. We invite your inquiries on its application to your product. There are Siebert equipment, methods or processes for Bakelite, Lucite, Cellulose Acetate, Urea, Cast Phenolics or Celluloid products.

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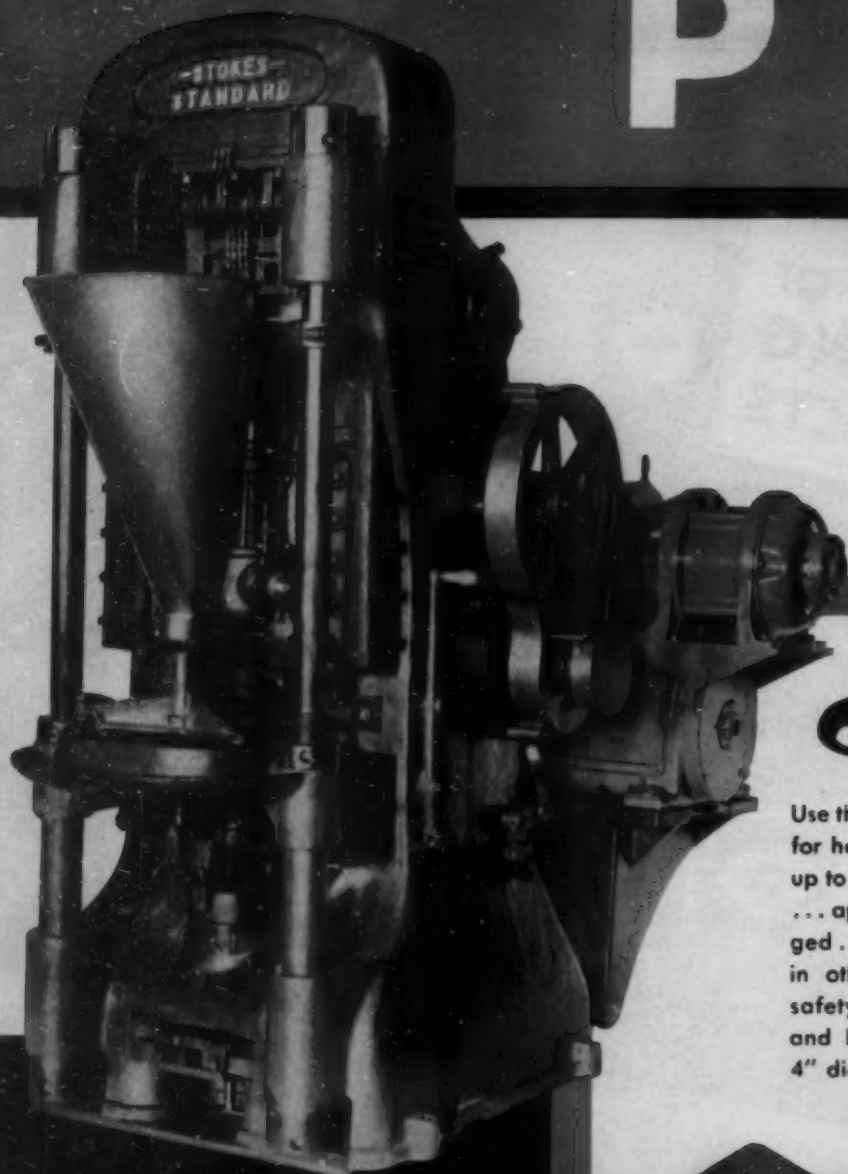
## RUDOLPH R. SIEBERT

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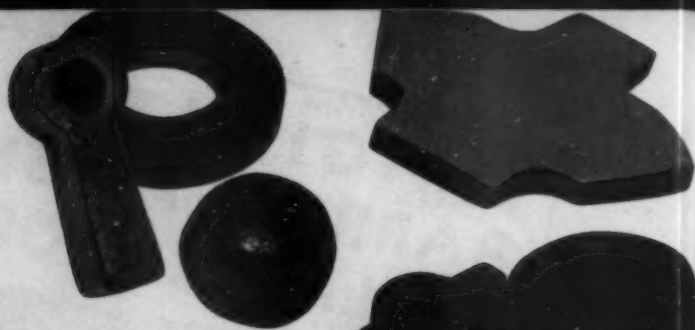
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# P R E F



## *Size*

Use the Stokes Standard No. 280 Press for heavy-duty preforming . . . pieces up to 4" diameter. A toggle type press . . . applying 80 tons pressure . . . rugged . . . semi-steel construction and, as in other Stokes Preforming Presses, safety features that prevent jamming and breakage. Two models, 2" and 4" die fill.



# *F. J. Stokes*

# FORMING

Preforming saves time and money in various ways. It reduces bulk of materials, simplifies handling, speeds up mold loading, puts an exact quantity of material into each cavity.

Ball preforms are particularly advantageous for long, narrow pieces and some special shapes . . . they readily crush, leave no marks on finished work. Used in multiples, they are frequently more economical than specially shaped preforms.

For preforms that are accurate in weight and of uniform hardness throughout . . . for equipment that will produce them economically . . . use Stokes Preform Presses.

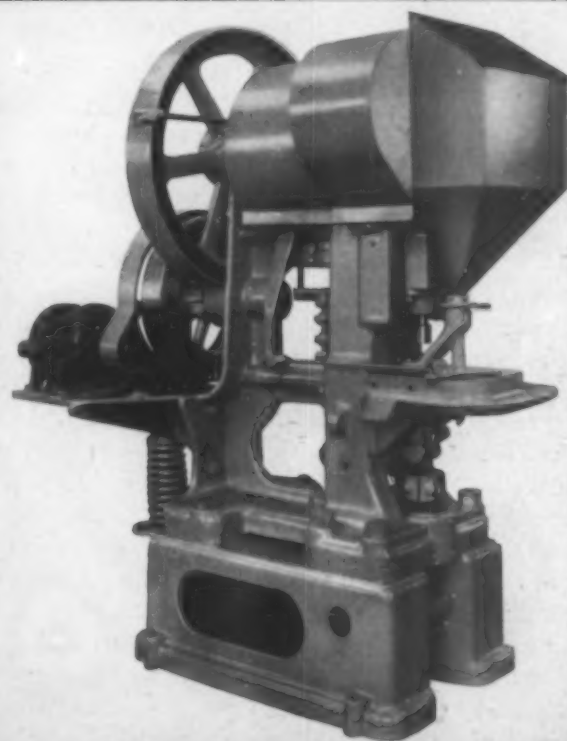
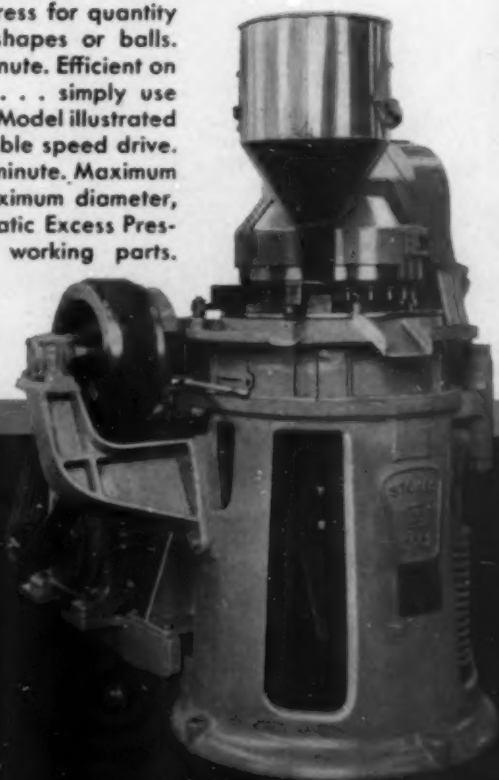
These presses are built in twelve types and sizes developed to meet the complete range of preforming requirements. They are substantial, rugged presses with semi-steel frames. Safeguarded to prevent jamming. Self-contained machines, compact, clean—protected from dust, quickly changed, easily adjusted for pressures. Write for catalog or recommendations. See Stokes' preforming exhibit at the Chemical Show, Grand Central Palace, New York—Dec. 6-11, Booth 80.

F. J. STOKES MACHINE COMPANY

5934 Tabor Road Olney P. O. Philadelphia, Pa.

## Speed

Use the Stokes Rotary Press for quantity production — standard shapes or balls. Output up to 600 per minute. Efficient on limited production also . . . simply use fewer punches and dies. Model illustrated is No. D.D.S.2, with variable speed drive. Output 300 to 350 per minute. Maximum depth of fill, 2" . . . maximum diameter, 1<sup>3</sup>/<sub>16</sub>". Semi-steel. Automatic Excess Pressure Release. Housed working parts. Six models.



## Versatility

Stokes "R" Press is a general purpose machine, for preforms up to 2<sup>1</sup>/<sub>2</sub>" diameter. Versatile. Quickly changed from one job to another. Efficient on long runs or short. Automatic Excess Pressure Release prevents jamming and breakage. Production 40 to 50 per minute. Maximum depth of fill, 2". Other models.

MOLDING EQUIPMENT



## FINISHING PLASTIC SURFACES

(Continued from page 228)



Two steel tumbling barrels mounted on one shaft that may be used for both dry and wet tumbling of small molded pieces. (Photo courtesy Rudolph R. Siebert)

color and transparency of the plastic material.

The procedure to follow in tumble polishing depends entirely upon the material used, the size and shape of the article and the ultimate finish desired. Small articles made of cast phenolic can be tumbled to a high permanent luster within 18 to 24 hours. The pieces are first subjected to an ashing operation, using wood pegs and ashing compound, and allowed to roll from 6 to 8 hours depending on the roughness of the surface. The average speed of the tumbler is 29 RPM. The pieces are then sifted and pass through a second period with burnishing compounds and pegs. The speed of the tumbler for this operation is usually 23 RPM. A highly burnished, semi-polished surface can be obtained within a period of 8 to 12 hours. If a higher luster is desired, the pieces are tumbled a third time, together with polishing cream and pegs. The average speed for this operation is 33 RPM and requires from 30 minutes to 1½ hours. The above procedure is usually followed by concerns manufacturing an inexpensive line of merchandise. Articles requiring a better finish can be processed in the same manner within a period of 27 to 36 hours and oftentimes when this length of time is allowed for tumbling, the pieces are said to have better luster and more uniform finish than those which have been polished by hand.

Special compounds are available for tumbling large pieces without pitting the surface. Pieces with fine carvings, holes, spots (such as dice) and jewelry are tumbled with creams and pegs, instead of sawdust ashing, burnishing and polishing compounds to prevent filling the holes or carvings. Crystal and other clear materials can also be tumbled successfully, without chipping, by using special compounds. Small articles such as buttons, buckles and novelties are usually ashed,

burnished and polished completely in a tumbling barrel. Approximately 70 to 85 percent of the large pieces are also tumbled to the desired luster, and the remaining 15 to 20 percent are ashed, burnished and wiped on a buff containing a greaseless polishing compound.

The polishing of molded products is accomplished easily and quickly in a tumbler rotating at approximately 33 RPM. Tumbling pegs and a sufficient quantity of pieces are combined to half fill the tumbler. Objects which come from the mold with a smooth polished surface require but one tablespoon of polishing paste to the batch and the time required for tumbling varies from 45 minutes to 1½ hours. Objects that leave the mold with a dull surface or those shaped from sheet stock with a fine sawed or beveled edge, require from 2 to 3 tablespoons of polishing paste and from 3½ to 5 hours polishing to produce a good luster.

The possibility of automatically finishing plastic materials with a high, lasting gloss is being seriously considered. From reports obtained in several representative plants, new methods of tumbling plastic materials today are practically foolproof, and a good ashing, burnishing and polishing job can be performed with definite results.

Some concerns still use hand polishing for superior, individual work. Ground pumice, mixed with water until it becomes paste, is applied to a buff wheel approximately 14 in. to 16 in. in diameter and 3 to 4½ in. wide. The piece to be polished is rubbed on the wheel until a smooth surface is obtained. Some parts require fine pumice while others respond more readily to coarse pumice. The average grade used is No. O. Some concerns use No. O and F together and the wheel for this operation should move at about 1800 RPM. After the pieces have been rubbed, they are washed, dried, and then tripolied on a flannel buff. The tripoling is usually accomplished on a buff that is 12 in. to 14 in. in diameter and 4 in. to 5 in. wide. The composition for this buff is either tallow bound or stearic acid bound tripoling compound. The tallow bound compound is inclined to leave a greasy surface whereas a stearic acid bound compound produces a clean, smooth finish. The wheel for this operation should hold a speed of about 2100 RPM. After the parts have been rubbed and tripolied, they are given a wiping operation. This is usually done on a flannel buff that is 12 in. to 14 in. in diameter and 3 in. to 4 in. wide, to which is applied a fine tripoling stearic acid bound composition. This composition comes in the form of a bar which is rubbed lightly against the buff. Best results are obtained when but a little of the compound is applied to one half of the buff, the other half being without any composition. A speed of 2900 to 3100 RPM is used for this operation. Plastic objects have a high luster when they are given three hand-buffing operations.

Articles too delicate to be completely polished in a tumbling barrel are ashed and tripolied in dry tumbling barrels, then hand wiped. Hand wiping brings out the finish to practically the same degree as hand rubbing and hand tripoling operations. It will probably be but a short time before these individual small lots will be completely finished in tumbling barrels.

# WATSON STILLMAN

*hydraulic*

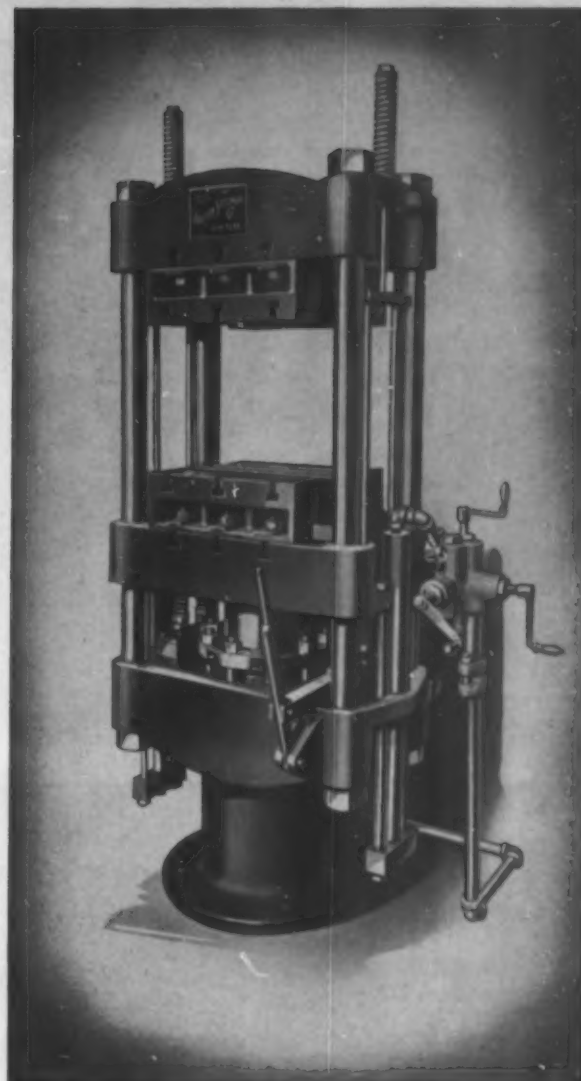
## MOLDING PRESSES

Whatever your molded product is, Watson-Stillman has a press for its production.

A complete line, including semi-automatic and plain types, Angle Molding and Tilting Head Presses, all are designed to meet the requirements of today's high production demands.

A wide variety of types and styles makes it possible to select the press that is best suited to your particular needs.

Watson-Stillman Presses can be furnished arranged for operation from an accumulator system or as complete self-contained units requiring no auxiliary equipment.



105 Ton Watson-Stillman  
Semi-Automatic Molding Press

HYDRAULIC PRESSES  
FOR EVERY PURPOSE

HIGH PRESSURE PUMPS

ACCUMULATORS  
HYDRO-PNEUMATIC  
WEIGHTED TYPES

OPERATING VALVES

LEATHER PACKINGS

FORGED STEEL FITTINGS

The Semi-Automatic Press illustrated is built in five standard sizes. Capacities range from 60 to 450 tons.

All sizes have hydraulic pullbacks with bronze pullback rams.

Mechanical ejectors of positive action are furnished for top or bottom platens or both as required.

Watson-Stillman Presses of this type are used extensively for the molding of a variety of plastic parts.

Consult us regarding your requirements. Our Engineering Staff will be glad to serve you. There is no obligation.

**THE WATSON-STILLMAN CO.**

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## HEAT FOR MOLDING PLASTIC MATERIALS

(Continued from page 222)

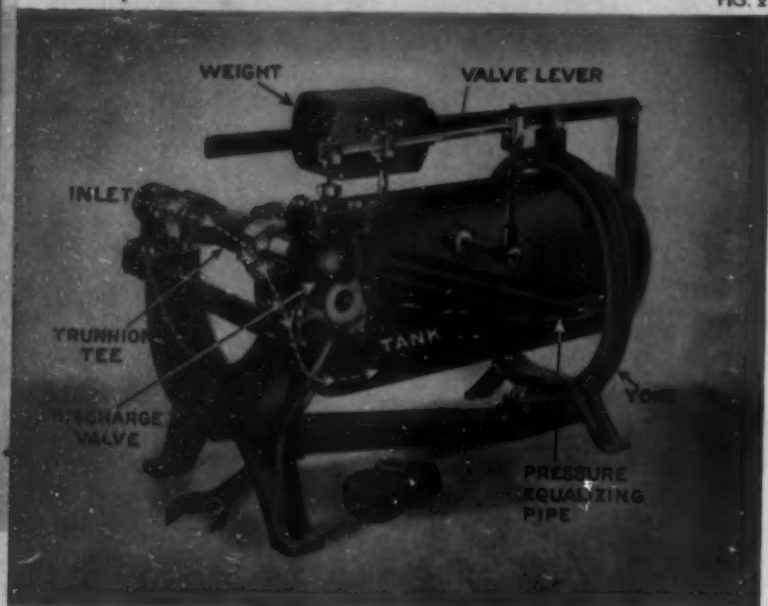


FIG. 2

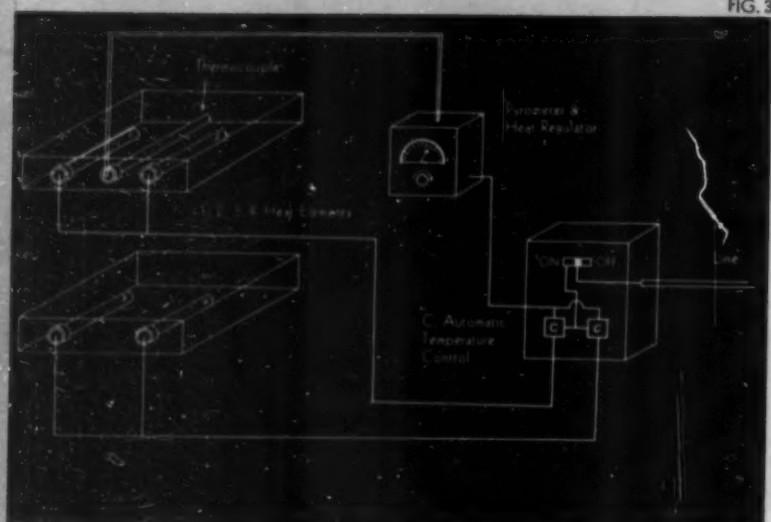


FIG. 3

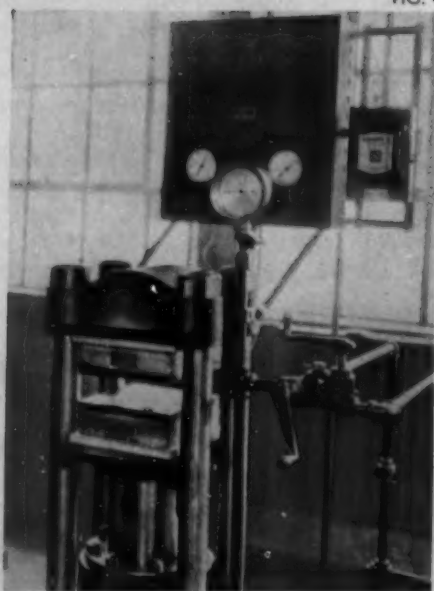


FIG. 4

HAROLD E. TRENT

are usually provided for this purpose, one type of which is illustrated in Fig. 2. The cost of heating by steam, or the boiler horsepower required per press, is dependent upon many factors, such as the area and mass of platens and molds, type of press (laminating or molding type), insulation of heated masses from surrounding structure, ventilation of press room, whether or not chilling of mold and platen is required and efficiency of traps and other accessories.

### Compression molding by electrical heat

Since electrical heating requires no piping, it is eminently desirable from the standpoint of convenience in installation. Illustrated in Fig. 4 is a controller panel and press, equipped with electrically-heated platens while in Fig. 3 may be seen a wiring diagram for such an installation. The heater elements, which should be tightly fitted into their individual openings to ensure proper heat conductivity, may be of either the cartridge or strip type and the number and capacity of elements required vary with the area and mass of the platens. While electricity is not used extensively for heating press platens, there appears to be a growing interest in this method. At least one large plant operates a battery of forty-five presses with electrically heated platens and Fig. 5 presents a rear view of a press from this particular battery, showing the strip heater elements in place in upper and lower platens together with the connecting leads. According to this user of electricity for heating purposes, this method has decided advantages which are outlined in the following quotation from the concern:

"In each platen are installed four electric steel-clad heaters, either of 250 or 500 watt size, depending upon the press and the temperature required. Asbestos boards serve as thermal insulation between the platens and the press fittings. Platen temperatures may be kept very low; for example, some types of light colored material, thermoplastic compositions, etc., require low, carefully controlled temperatures. For this purpose several of the presses are provided with rheostats. For the phenolic resins and darker colors the platens are operated at temperatures of 200 deg. C to 250 deg. C. Each press is equipped with a time clock, switches, terminals and provision for testing to avoid improper temperatures.

"The advantages of the electrically heated presses are: Higher temperatures for darker colored materials shortens the molding cycles for maximum production from existing molds; Installation costs are reduced to a minimum; Swing joints or flexible connections, valves, piping, and in some instances, steam pressure regulators are avoided; Less expensive platens may be substituted for the channeled platens; Hazards at connections of high steam pressures are avoided; Cleanliness results from the absence of poor piping connections or leaking valves; Maintenance costs are reduced as there are no valves or piping to replace in the heating system; Less loss of time in production results as in the rare instances of repair but little time is required; The quality of the material cannot be impaired through leakage in the steam lines; The compactness of the unit makes it possible to

# *The* **CARVER LABORATORY PRESS**

*for*  
**PLASTIC MOLDING**

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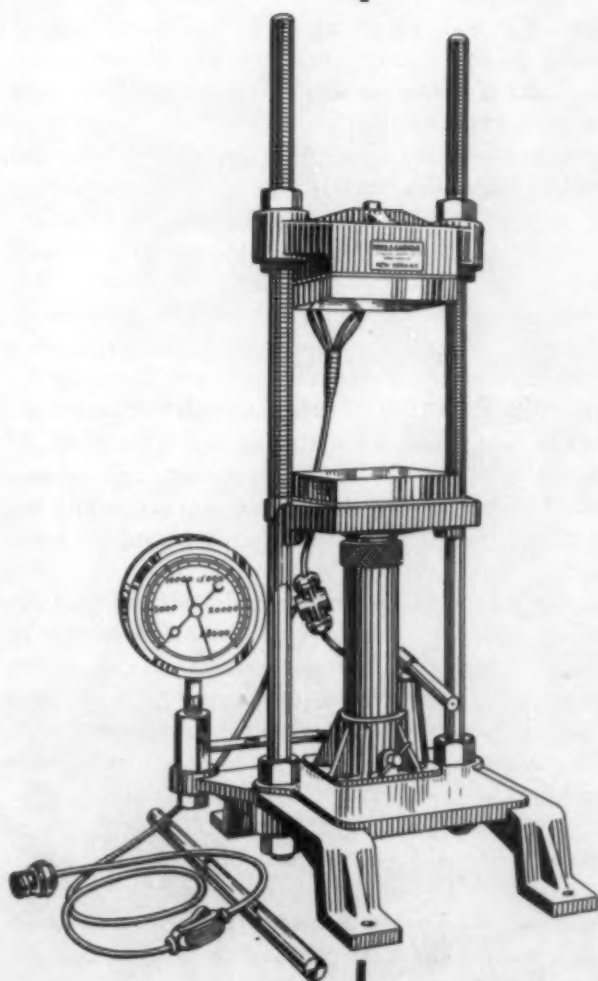
Provides for testing single cavity molds,  
making samples, development and re-  
search work.

It is always ready for instant use—a  
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Weighs only 125 pounds—yet power-  
ful—good for 0 to 20,000 pounds.  
Fitted with electric or steam hot plates  
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HYDRAULIC EQUIPMENT

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FIG. 5



J. J. KREMBEL

FIG. 6

utilize a limited floor space for a greater number of presses; Electrical heating is of particular interest in many instances where high pressure is not available. This is not an unusual situation as a few presses are frequently installed for the production of molded parts."

Many factors will, of course, influence the cost of operating electrically heated platens, one being the k.w.h. rate of the local utility company. The experience of another company using a few electrically heated presses is summed up as follows: ". . . . . I do not believe we have a mold that costs us over ten cents an hour to heat when in continuous operation. The 6 cavity mold for the . . . . . base uses approximately 6.3 k.w. per hour and an average cost per k.w.h. is 1½ cents."

#### Compression molding by gas heat

The third and least extensively used method of heating platens and molds is by gas, generally found in small plants and but few of those, although successful opera-

tion and low operating costs are claimed by some of the concerns using this method. The essential equipment of this system consists of compressor, respirator and burner. The burner, usually of the ribbon type, is mounted directly under the mold mounting platen where the flame will come into direct contact with the platen; the compressor maintains the proper pressure, and the respirator mixes the proper amount of air desired for combustion. A temperature control may be installed in the gas delivery line, and because of the compactness of the equipment, very little space is required for installation. The initial cost of the system is low and due to the relative simplicity of piping, the installation costs are also low. This type of heating does not permit alternate heating and chilling of the mold, however.

It is rather difficult to compare costs for these three heating methods but it is safe to say that gas costs roughly twice as much as steam while electrical heating runs several times the cost of steam unless a particularly favorable rate per k.w.h. is available. In spite of this, oftentimes the convenience of electricity and gas offsets the additional cost, particularly in small installations.

#### Heating for injection molding

Molds used in the new injection molding machines are not heated, nor are the mold mounting plates. The latter, and usually the molds as well, are channeled for continuous circulation of cold water, in order that the injected thermoplastic material will "set" or harden quickly. Fig. 6 shows an injection machine with mold mounting plates, heating cylinder and thermometer. The cylinder is heated by an electric element, although in one press available the heating medium is circulating hot oil, the oil being heated by an electric element. Automatic adjustable temperature controls maintain a fairly accurate temperature in the heating cylinder. The thermoplastic material is softened to a viscous mass in the nozzle end of the heating cylinder and a ram driven at high pressure forces the proper amount of molding material through a small orifice in the nozzle into the gate and runners of the cool mold, and then into the cavities. As the thermoplastic materials are poor conductors of heat, there is a slight lag in the "setting" or hardening of the material when it contacts the cool surfaces of the mold. This lag is sufficient to permit the material to completely fill the cavities before it "sets" or hardens.

It will readily be seen, therefore, from these brief descriptions, that an unlimited and continuous supply of controllable heat is of paramount importance in all hot molding operations, whether thermosetting or thermoplastic materials are used. And this is equally important whether compression molding or injection molding is being done.

The methods of securing this inexhaustible supply of controlled heat will vary greatly under specific conditions and each operator of a molding plant must weigh circumstances and obtain accurate comparative costs before determining the most practical and logical installation to employ.

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The most complete line of mixers ever developed . . . Mixers for every kind of laboratory, pilot plant or production service . . . Mixing, Kneading, Pulping and Shredding, Dissolving, Dispersing . . . No matter what your problem or what your production . . . No matter what your Plastic Product . . . you can secure complete satisfaction through the use of Baker Perkins equipment.

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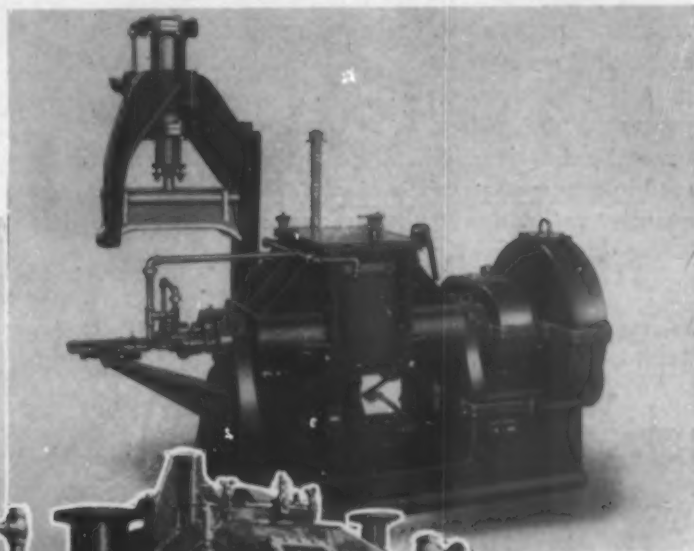
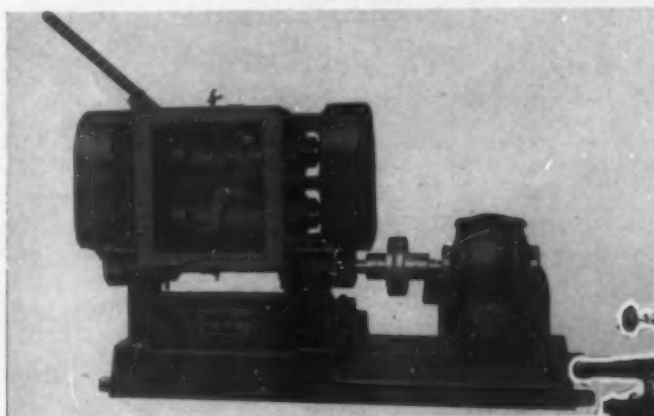
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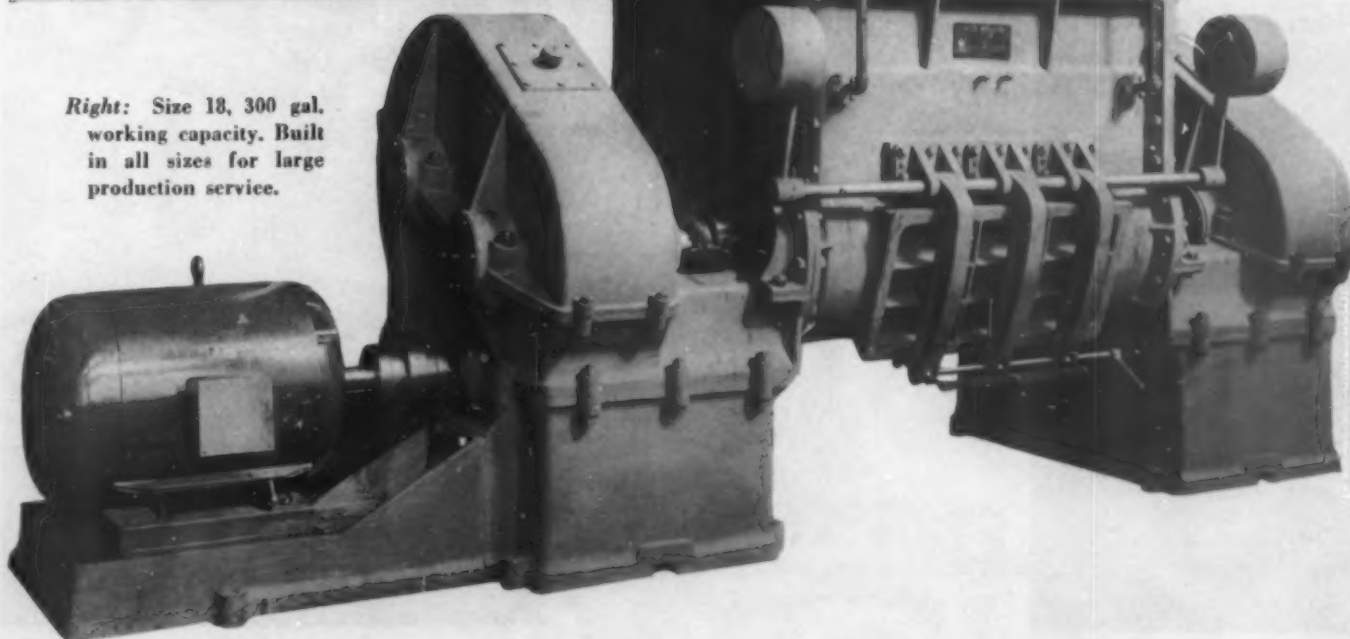


*Below:* Size 6, 2½ gal. working capacity. Small shredder for laboratory service.

*Right:* Size 11½, 10 gal. working capacity. For Pilot plant or small production service.



*Right:* Size 18, 300 gal. working capacity. Built in all sizes for large production service.



## MOLDING PLANT EQUIPMENT

(Continued from page 213) piping to the press usually has a section of the proper length that can be removed, where the reducer will fit with no pipe cutting.

Hydraulic pressure is generally used for applying pressure to molds and to operate efficiently there should be at least two hydraulic lines: a low pressure of 250 to 500 lbs. per square inch for the heavy work of moving the press up and down, making it possible to lightly close the press and thoroughly heat and soften the material; and a high pressure of 2000 to 3000 lbs. per square inch for the final closing of the mold. Each hydraulic line consists of pump and accumulator with proper operating or control valves.

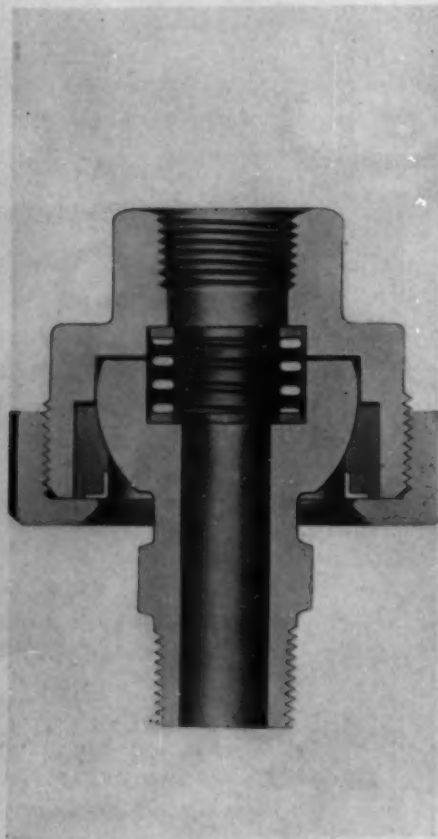
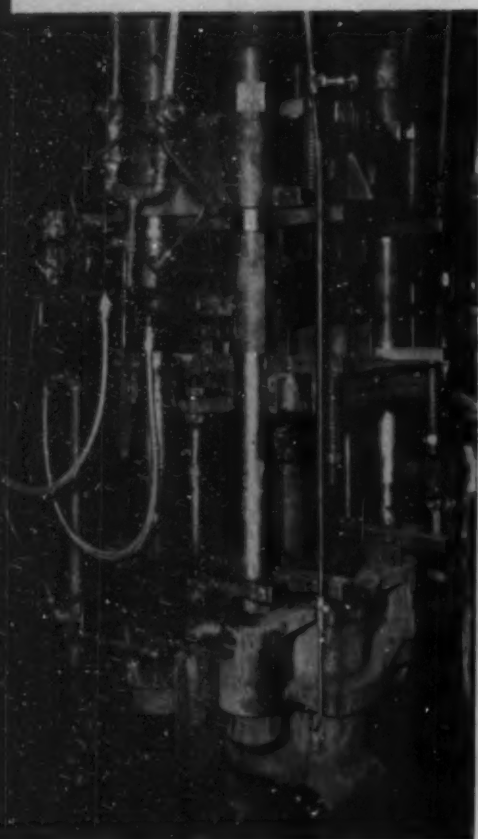
The hydraulic pump forces liquid into the accumulator cylinders, bringing about a definite pressure which is distributed to the presses and controlled by various types of operating valves. Both high and low pressure accumulators are served by their own individual pumps and in practically all instances, these pumps are of the reciprocating type, either electric or steam driven, with capacities for any pressure from 200 lbs. to 6000 lbs. and power consumption from 3 H.P. to 600 H.P. The pumps may be horizontal, or where space is a factor, a vertical pump is available. Hand pumps are sometimes used in connection with hand molding presses for small quantity production. Whatever type of pump is used,

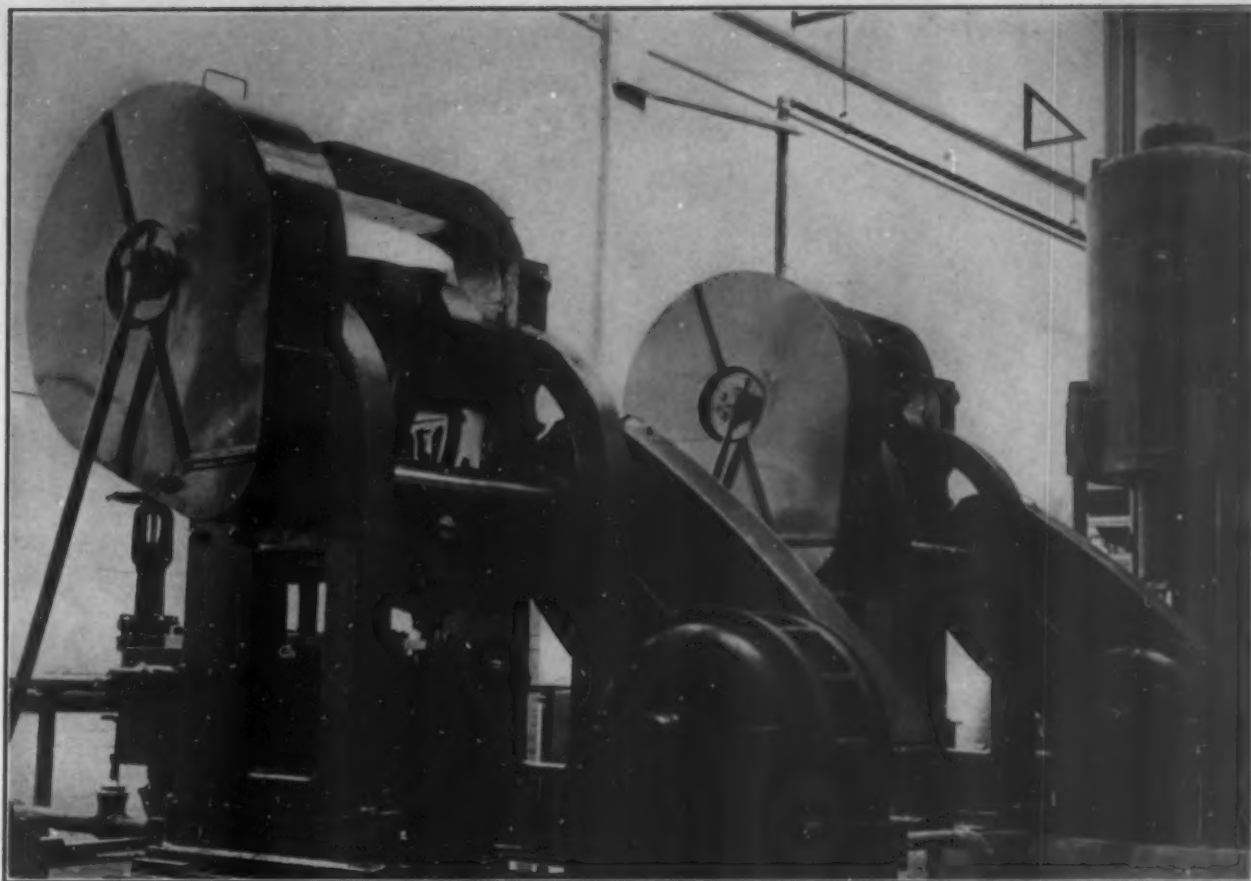
some molders believe it essential to have two of each. Then if it becomes necessary to repair one pump, the other starts operating at once with no loss of time.

The accumulator is simply a pressure storage vessel provided with suitable ram or piston and so loaded or weighted as to provide hydraulic pressure equivalent to the working pressure desired at the molding presses. The accumulator system is employed where several presses are to be served and in most instances, two are used, one to supply low pressure during the initial part of the press stroke and the other to admit high pressure into the press cylinder to give the final squeeze. There are two main types of accumulators used in connection with hydraulic systems to control pressure when too many demands are made upon it. The gravity type is more common and will perhaps be found in the great majority of plastic molding plants. This accumulator consists either of a vertical ram loaded with heavy cast iron weights, or a ballast tank loaded with scrap material. Since this type of accumulator is extremely heavy, it is sometimes relegated to the basement and usually placed in a pit to provide head room above it. Sometimes it is located conveniently out-of-doors.

The second type, the air-loaded or hydro-pneumatic accumulator, while comparatively new in this country, has been in use in Europe for a great many years. In this accumulator the ram is acted upon by air pressure contained in a supplementary air vessel whose pressure is

Left—Flexible metal hose for conveying steam and hot water, alternately, to dies or platens on molding press. (Photo courtesy The American Brass Co.). Center—Swivel joint by Barco Mfg. Co. Right—Mold pyrometer for rapidly and accurately measuring internal temperature of molds. May be used upon stationary surfaces of almost any contour. (Photo courtesy Cambridge Instrument Co.)





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The Aldrich Hydraulic System for Plastic Molding is a centralized hydraulic power plant which offers the lowest operating and capital costs.

Consisting of high and low pressure Aldrich electric pumps equipped with patented output control devices, accumulators, fluid supply tanks, etc., it centralizes at one point in the plant, flexible hydraulic power to meet any variable demands and permits intelligent expansion as growth ensues.

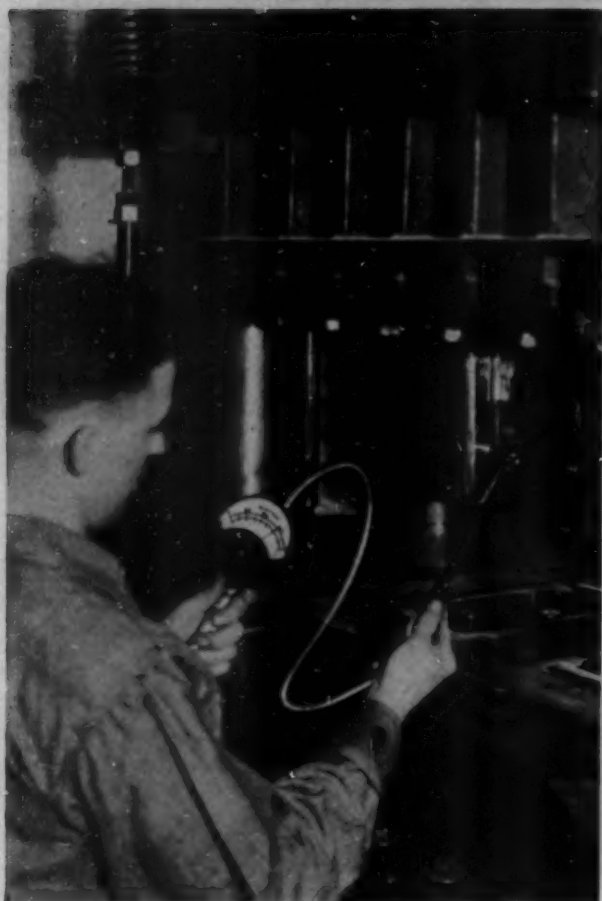
Aldrich offers the Plastic Molding industries the benefit of its many years of specializing in the design and construction of High Pressure pumps and hydraulic specialties for the industrial field.

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**THE ALDRICH PUMP COMPANY**  
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OCTOBER 1937

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Ultra-rapid thermo-couple pyrometer with self-aligning tip as used for checking die and mold temperatures at the Chicago Molded Products Corp. (Photo courtesy Illinois Testing Laboratories)



Experiments conducted at Chicago Molded Products Corp. indicate deficiencies of under-cured (two pieces at top) and overcured (two pieces at bottom) plastic material. (Photo courtesy Illinois Testing Laboratories)

usually comparatively low in ratio to the hydraulic pressure desired. This is accomplished by means of differential areas between the piston, against which the air acts, and the area of the ram which acts on the hydraulic system. By using air as a ballast, there is a practical elimination of shocks sometimes encountered with the gravity type of accumulator. The hydro-pneumatic accumulator may be located on upper floors of buildings without risk.

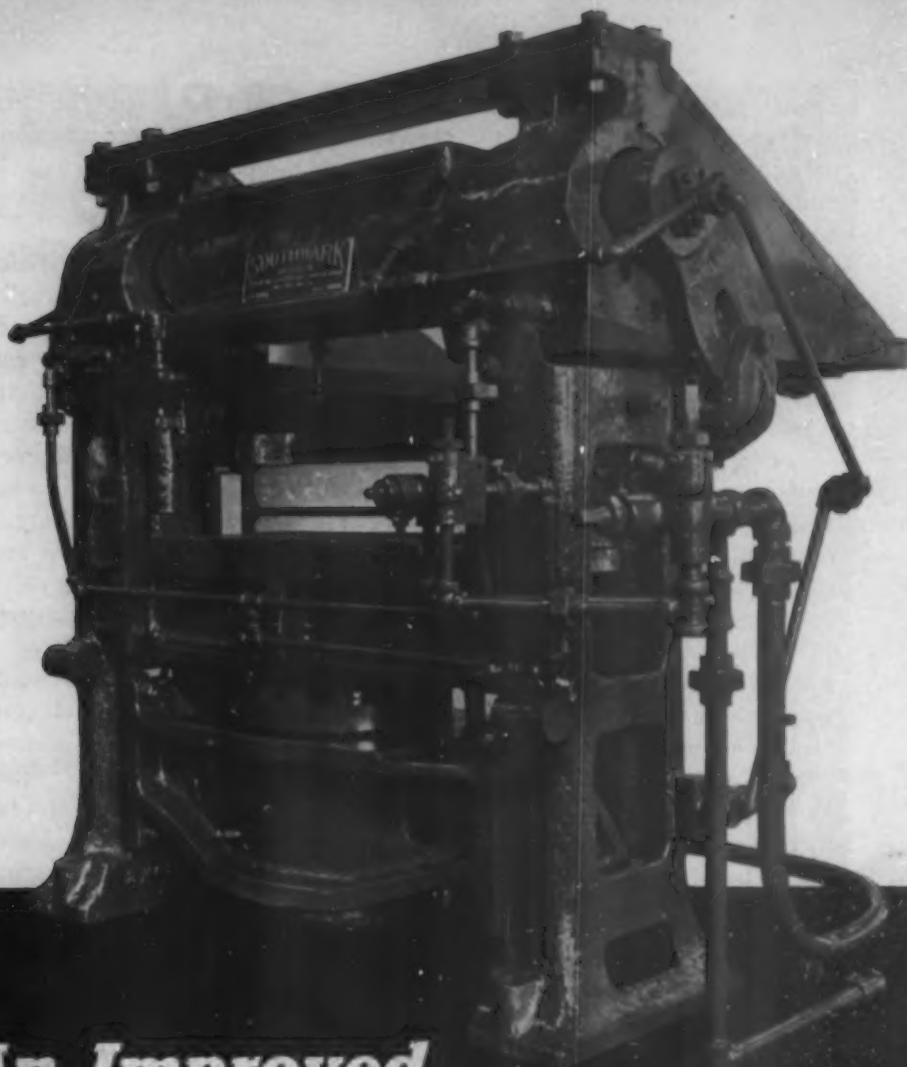
A reservoir for water storage is essential in a hydraulic system and it is also well to include a strainer for the purpose of removing small particles of foreign matter which may cause serious trouble by accumulating on valve seats or in cylinder packing. The discharge pipe enters one side of the reservoir at the top and dirt settles to the bottom. Water drawn from the reservoir to the pump must pass through a double fine wire cloth screen. There is so much water in the reservoir that drawing off does not cause any agitation and the solid particles remain on the bottom.

Closed hydraulic systems replace from 20 percent to 100 percent of the water with special oil. The oil seals incipient leaks, lubricates packings and eases the wear and tear on operating valves.

There is a wide variety of operating valves and the selection of the proper type is dependent entirely upon the service required and methods of operation in the molding plant. Older types were for the most part multiple spindle valves for controlling the admission of pressure and for permitting the press to exhaust when desired. Operating valves of a later type are built for either a single high pressure system or for the dual high and low pressure system. A dual pressure valve, of the four-way type, and suitable for a double-acting semi-automatic press, has proved popular in the industry and eliminates the many uncertainties of the valve requiring the manipulation of several different screw type stems. Another recent development in the control of plastic molding presses is the automatic valve. This is normally used in connection with an automatic timing device, working through an electric solenoid. These automatic timing devices can be so adjusted as to cause the press to make a complete automatic cycle; that is, closing the press, applying high pressure, allowing a suitable time dwell to permit the proper molding period, and finally releasing the pressure and opening the press, ready for a succeeding cycle.

There must be a hydraulic pressure gage or steam gage

*New!*



## **An Improved TILTING HEAD MOLDING PRESS**

### **FEATURES**

Adjustable stroke hydraulic push-pull ejector. Ejection at any point of platen stroke or head position. No cramping or binding of ejecting pins. Reseating is positive. Either top or bottom ejectors, or both, can be furnished. Substantial base. Side frames have stops to prevent over-stroking main rams. Complete specifications on request.

Developed to provide rigid, compact, highly productive presses with large platen areas and of any required press tonnage, this improved Baldwin-Southwark-Burroughs Tilting Head Molding Press marks a decided step forward in the art of molding thermo-plastic materials. The head is balanced, hydraulically actuated backward and forward in a horizontal plane, and rotated through an arc of 90°. Controls are simple, positive, adjustable. Head construction is rugged, doing away with deflection and insuring correctly pressed pieces, without excessive flash, from center cavities even when large molds are used. Many features of design and operating advantages of this new press should interest you . . . let us tell you about them.

**BALDWIN-SOUTHWARK CORP.**

Southwark Division, Philadelphia

Pacific Coast Representative: THE PELTON WATER WHEEL CO., San Francisco

# **SOUTHWARK PRESSES**

on each press. These are of a standard type and usually have graduated dials so that the gage will indicate not only the hydraulic pressure per square inch on the press ram, but also the total tons pressure exercised by the press on the dies. Ordinarily these gages are used only for occasional checking of pressure and are shut off by means of a small choker valve during long runs of the press in order to avoid injury to the gage mechanism which is of a rather delicate nature. In addition to the gages at each press, there should be a master steam gage to control the main line steam pressure.

The pipe lines connecting each press with steam, hydraulic, water, air or drain are of utmost importance and must be of a size and construction to do the job required of them. For instance, steam piping must be large enough to provide the same steam pressure to each press and as far as possible should be carried in straight lines to ensure a steady flow of uniform heat. They should be adequately covered to guard against loss of heat on its way through the plant. The size of hydraulic piping depends to some extent upon the distance of the accumulator system from the presses. It is considered good practice by most molders to adopt a color code for the pipe lines so that each may be easily distinguished.

Flexible metal tubing through which steam is conveyed from the main steam pipe line to the dies and platens of the press, together with appropriate flexible joints

must be installed on each press. These must be of proper construction to withstand constant flexing as the press opens and closes.

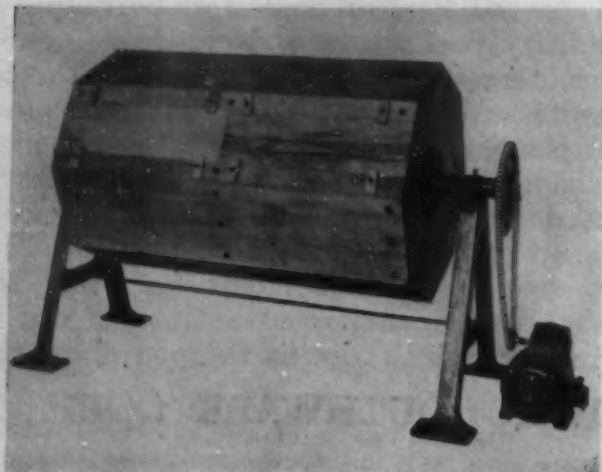
#### Auxiliary pipe lines

In addition to the hydraulic and steam lines, water lines, usually connected with the town water supply, are piped to each press for cooling and chilling molds. Although present day thermosetting materials are so developed that they need cooling only for an excessively fine surface or to maintain dimensions, it is generally considered practical to have water available for the purpose. Injection molding of thermoplastics requires this method of chilling.

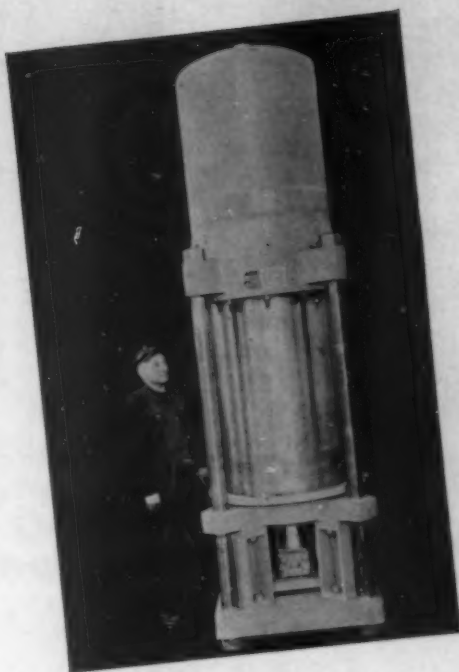
There must be a complete system of air pressure throughout the shop. An air compressor and tank are used to supply air at each point where quick cleaning is necessary—at the presses, where a cold blast of air serves to remove flash and bits of material from the mold; in the finishing room, to blow dust from pieces before they are polished; in the preforming room, etc. Usually a flexible hose equipped with a nozzle valve is placed conveniently for the operator to handle. Traps and strainers used in connection with the air pressure system to remove moisture and oil must be cleaned frequently.

An adequate dust collection system is also imperative in each molding shop. Exhaust hoods are located at

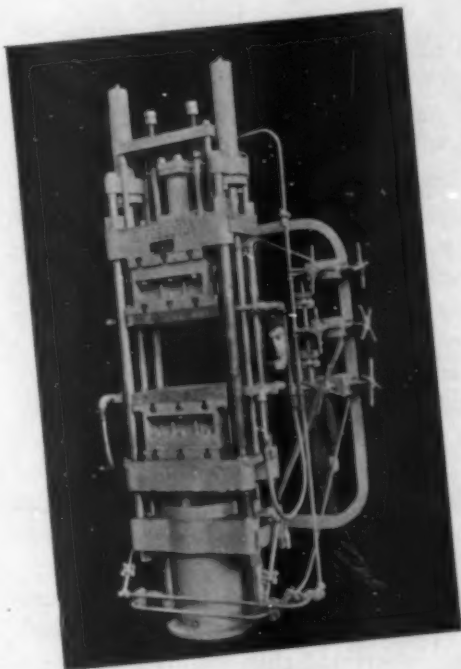
Upper left—Efficient pyrometer with offset handle for flat surfaces. (Photo courtesy Pyrometer Instrument Co.) Right—Portable pyrometer lance for checking mold temperatures. Made by Russell Electric Co.



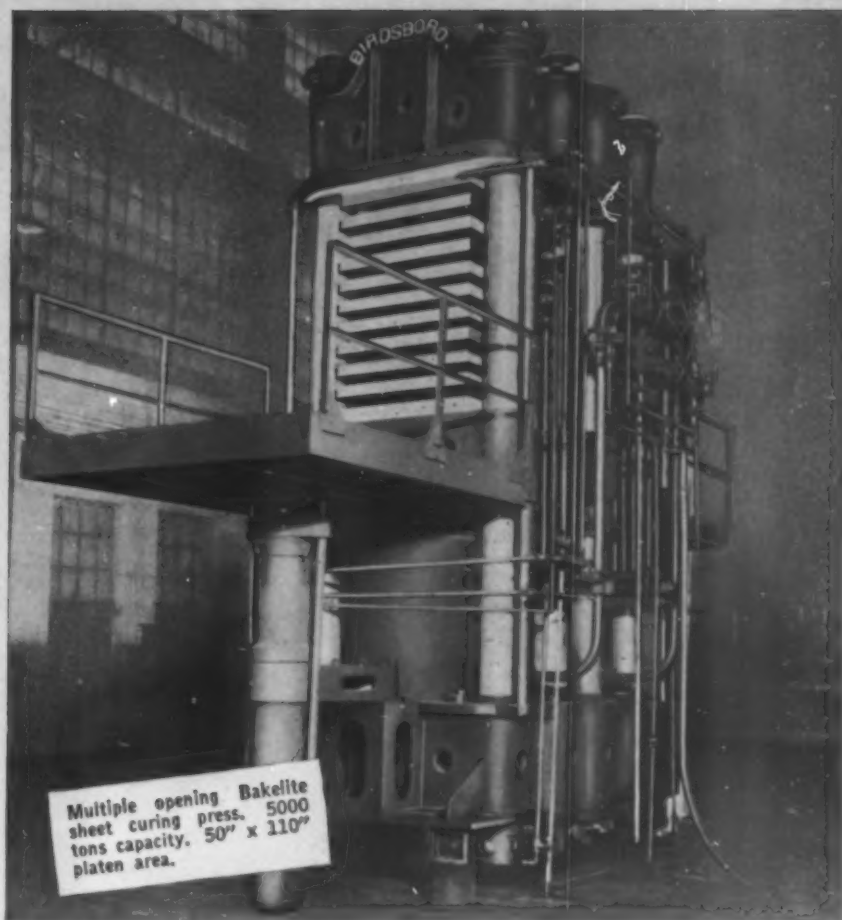
Lower left—Hard maple polishing barrel with direct motor chain drive. (Photo courtesy Rudolph R. Siebert.) Right—Metal shell, hard maple lined tumbler. (Photo courtesy Lupomatic Tumbling Machine Co. Inc.)



The Birdsboro line of Accumulators includes the Ballast Weight type as well as the Hydro Pneumatic as illustrated.



Semi-Automatic Molding Press for multiple or single die molding. Built in sizes and capacities to meet your requirements.



Multiple opening Bakelite sheet curing press. 5000 tons capacity. 50" x 110" platen area.

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From drawing board straight through to finished job, Birdsboro hydraulic engineers closely supervise the construction of your press. The entire process of manufacture takes place under their own roof. That, too, helps to account for Birdsboro's long established reputation for quality and performance.

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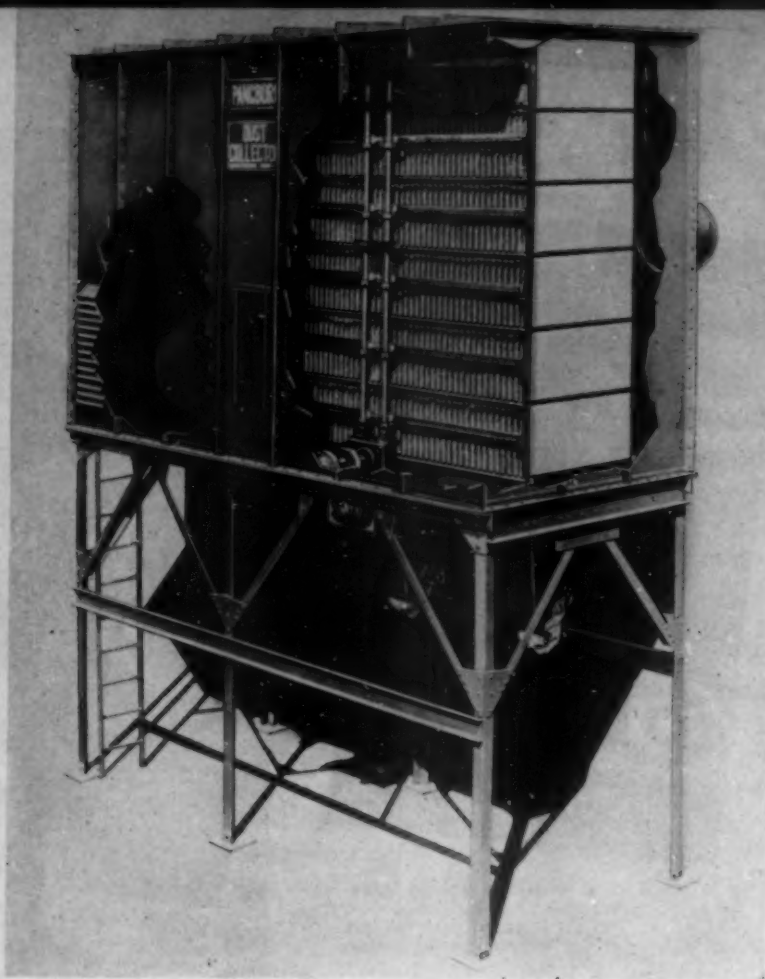
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HYDRAULIC MACHINERY • SPECIAL MACHINERY • CRUSHING MACHINERY • STEEL CASTINGS • STEEL MILL EQUIPMENT • STEEL AND CHILL ROLLS

OCTOBER 1937

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Upper left—Electric oven for preheating sheets of plastic material. (Photo courtesy Harold E. Trent Co.) Lower left—Scale with dial that can be read at 40 feet. (Photo courtesy Exact Weight Scale Co.) At right—Completely assembled dust collector cut away to show clear air partition grids sealing dust from clear air side and arrangement of screens in the casing. (Photo courtesy Pangborn Corp.)

each point where an appreciable amount of dust is always evident and a piping system connects these hoods to the dust collecting equipment. The source of suction or exhaust provides proper distribution of air flow from the various hoods, with a conveying velocity sufficiently high to carry the entrained dust, without settlement, to a huge vat located outside the shop where it is filtered and blown outside. Piping for the dust collecting system should be installed in as direct a line as possible with minimum changes in direction and elevation.

Molding presses on which light colored compounds are being molded, must be shrouded with fabric or otherwise enclosed to prevent powders of another color or dirt from a nearby press from contaminating the load. Even the tiniest speck of dark material will ruin a light colored molding beyond redemption. Once molded, the speck cannot be removed. In some of the more modern plants, presses are enclosed in individual rooms with glass partitions. Each room is equipped with two screened blowers which suck fresh air into the room at a point near the floor and exhaust hot air near the ceiling.

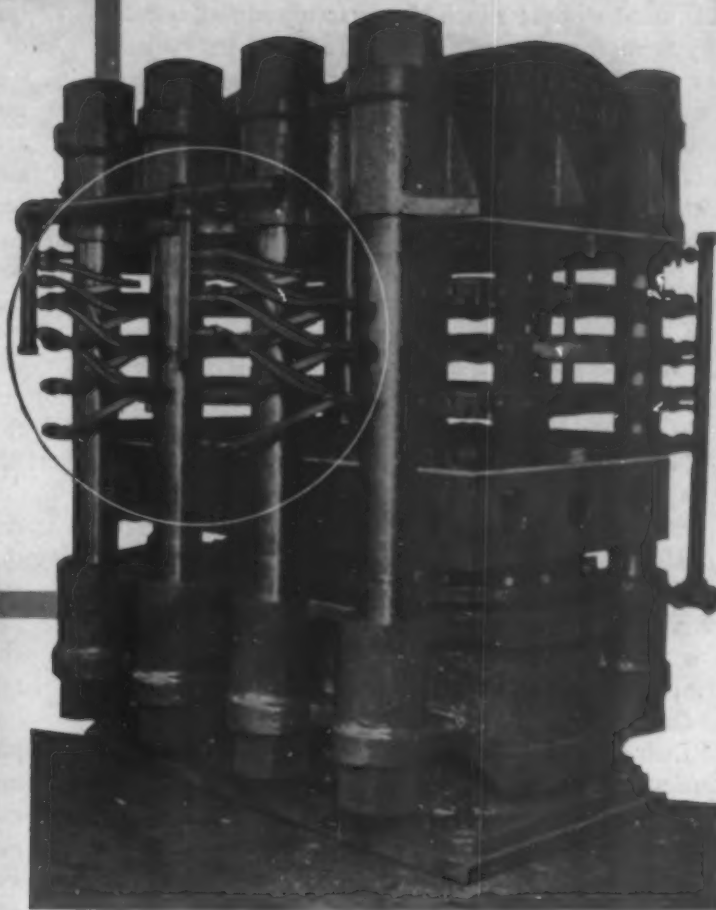
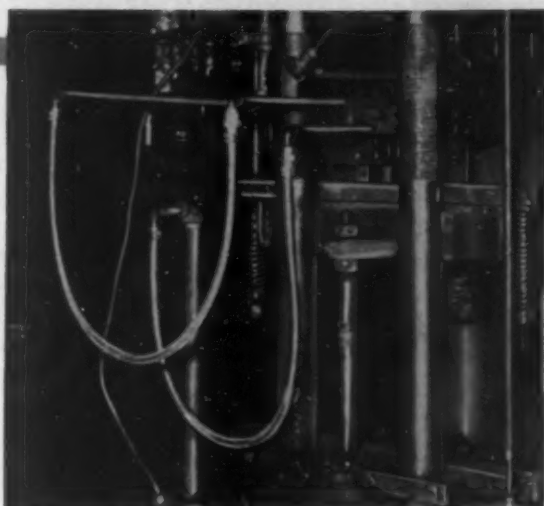
#### Accessory equipment in the molding room

*Pyrometers* are generally considered indispensable for checking mold cavity temperatures to conform with the temperature requirements of the material being used, for time and temperature are two governing factors in the production of satisfactory molded pieces. When the

temperature of the press is too high, an eggshell, dogskin or orange peel finish results. Too high a temperature also causes fading and discoloration. When the temperature of the press is too low, the mold does not fill out properly causing a defective product which means a high percentage of waste. Too low a temperature also causes blistering and sometimes other defects which are not immediately apparent. These pieces may seem to be perfect when first molded but after being exposed to air or use for a few weeks become warped and cracked and oftentimes shrinkage occurs. An uneven temperature between the top and bottom platens also causes warpage and shrinkage of finished products.

It is a custom of molders to establish a temperature-time relation that produces the highest quality of product and the fewest rejects and then maintain this temperature by constant checking with a pyrometer. Ordinarily such pyrometers consist of a sensitive, thin, flat strip thermocouple element connected to an indicator reading in degrees F. The contact couple is mounted in, and protected by a short insulating tube. This is hinged to a metal handle and is adjustable through a wide angle to permit its use in almost any position. When in use, the contact element is held against the heated surface with one hand while the indicator is held in the other hand. Connecting leads are protected against damage from accidental contact with heated parts of the molds and equipment by a flexible armored cable in which they are

# Flexible Metal Tubing *that is* really seamless



*American Seamless is simply installed on plastics molding presses and is thoroughly dependable for a long life without benefit of attention.*

*American Seamless is also available with a patented support to hold the tubing in a horizontal position. Send for free booklet.*

**I**T'S just as easy and cheaper in the long run to equip your presses with Flexible Metal Tubing that is SEAMLESS; actually manufactured from Seamless tubes.

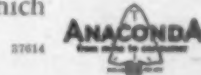
American Seamless Flexible Metal Tubing is fabricated from true bronze, monel and other metal *tubes* that insure in the finished product *leakproof* connectors that will give long, uninterrupted service in heating and cooling dies or platens.

The terrific temperature changes, when steam and cold water are alternately passed through flex-

ible metal tubing, call for the strongest, corrosion-resistant, long-life type of connector that can be found. American Seamless Flexible Metal Tubing is manufactured to fulfill these requisites.

American Seamless is available with both welded and "heat-proof-detachable" fittings. The latter type can be attached and detached in your own shop.

Information covering American Seamless Flexible Metal Tubing and fittings is contained in a 16-page booklet (Bulletin SS-3) which will be sent free on request.



**THE AMERICAN BRASS COMPANY**

## *American Metal Hose Branch*

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encased. Readings are practically instantaneous and less than one-half square inch of contacting surface is necessary with some types. These pyrometers are available in a variety of sizes and shapes and readings can be taken, not only at the press, but wherever temperature checks are required.

*Clocks*—mechanical or electrical or a combination of both—must be allotted each press unit. These should be capable of operating on 30 second periods up to ten minute periods so that when a workman fills the mold and closes the press, he will have an accurate indicator to tell him when sufficient time has elapsed to open the press. Usually there is also a master electric clock in the main molding room placed so that it can be seen from each press and referred to when longer cures are necessary.

*Counters* should appear on each unit. These enable the man at the press to estimate at any time during the day whether or not he is keeping up with his production schedule. At the end of his shift, his production is delivered to the inspector with a card indicating the number of pieces he has finished as registered on the counter. The inspector checks this amount with the pieces received and if there is any discrepancy a search is instituted at once for the missing parts, obviating the possibility of their turning up unexpectedly the next morning to confuse the daily records.

*Preheating equipment* must be available at presses where molding material is to be heated before being placed in the mold. For this purpose the simplest type of oven or steam table may be used, but in either instance, the heat must be controlled to prevent the material from plasticizing or becoming doughy. Preheated material is much softer and will flow easier, making it possible to operate the press faster, for less time is required to close it. This is a distinct advantage particularly when inserts of any sort are to be molded in.

*Loading boards* facilitate filling multiple cavity molds and help speed up the molding cycle. Preform loaders are constructed from either wood or metal, with the same number of cavities as are in the mold. These are

easily filled with a handful of preforms and the loader spaced above the die cavities. When the sliding bottom of the loader is removed, the preforms drop into the respective cavities in the mold. Powder loaders are similar in construction except that the cavities are larger to accommodate the greater bulk of the loose material. An adjustable type of powder loader is made for changing weights by providing telescoping tubes. Loaders must be made especially for each individual mold—usually constructed by the individual shops—for every molded piece has its own little quirks and peculiarities.

*Unscrewing devices* are required for removing caps or small threaded pieces from the mold in as little time as possible. A chuck driven by an electric drill is satisfactory for this purpose. A chain attached to the motor housing is passed over an overhead pulley and a weight on the other end pulls the chuck up out of the way when not in use.

*Arbor presses* are absolutely necessary wherever hand molds are being operated and should be located in close proximity to the press. These are used for separating the parts of the mold to remove the molded piece. Hand operated arbor presses are suitable for this work.

*Tote boxes* for carrying molding material or finished pieces from one place to another are essential in every molding plant. These should be of a size and construction to be easily handled even when filled. Some are made of metal and some of wood or other material. Folding wooden tote boxes are preferred by many molders because they can be piled neatly and take up but little space when not in use.

*Wooden benches* placed at right angles to each press provide convenient working space for the operator. These must be built to accommodate all the accessories needed by the pressman in his work. There should be ample room for molding material, inserts and loading boards, as well as for miscellaneous tools. These tools usually consist of brass scrapers, pliers, tweezers, small pieces of drill rod, etc., which are used to remove scrap or material that has broken off in the mold, and hammers to tap inserts into place. A shelf built under the bench supports a tote box to receive the pieces as they come from the mold.

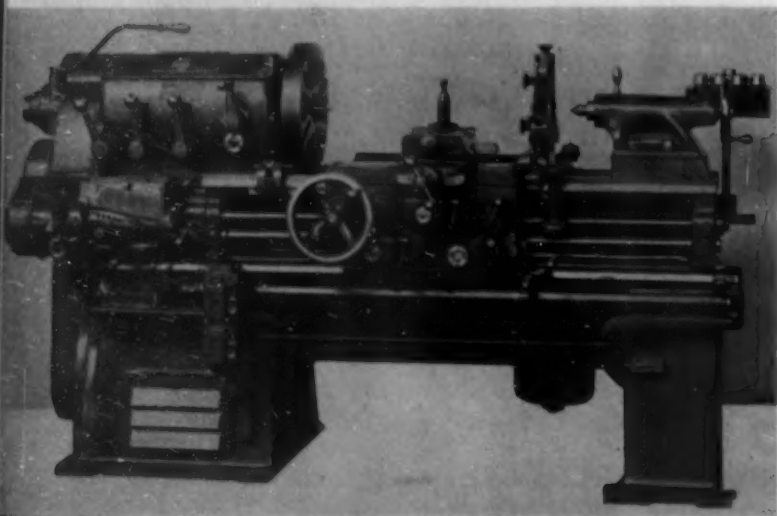
*Hand trucks*, or in some plants, conveyor belts, are used to relay molded pieces to the finishing department. These hand trucks are also used for moving about molds and often overhead cranes are installed to lift molds in and out of the press.

*Gloves* are essential for handling molds or working at the press, to prevent hands and fingers from being burned. These may be canvas or leather, or simply leather hand flaps which are sometimes preferred because they save the time necessary for putting on and removing gloves.

In addition to standard equipment in the molding room, each plant accumulates a miscellaneous assortment of machines and gadgets built to accomplish specific operations. Some of these are used for only one job, but are seldom discarded since there may be a possibility of using them on some future occasion.

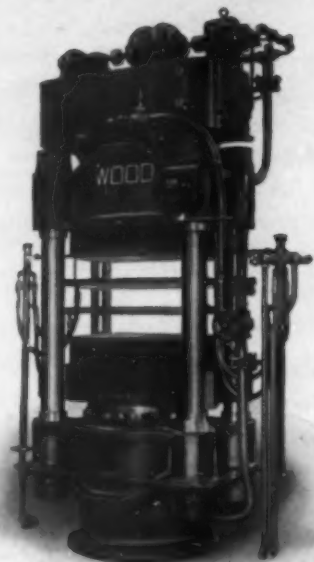
(Continued on page 248)

14 in. geared head toolroom lathe.  
(Photo courtesy Reed-Prentice Corp.)



# PROGRESS

IN ACCURACY, SIMPLICITY, SPEED



750-ton HydroElectric 3-opening Precision Steam Platen Press, capable of instant pressure regulations between 300 and 2000 lb. per sq. in. on its steam platen area. The pressures, which are read directly from the dial, can be maintained indefinitely without attention by the operator.

These presses are merely a few of the types we regularly manufacture.

We manufacture Semi-Automatic Molding Presses with spring pullbacks or hydraulic pullbacks.

We manufacture steam platens in any size.

Our improved hydraulic operating valves and two-pressure valves are made in all sizes for any required pressure.

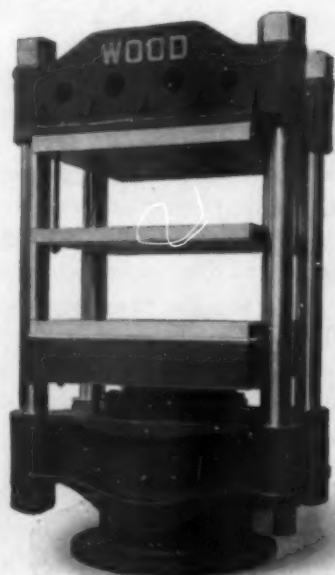
An experienced engineering staff will be glad to work out your problem.

A 660-ton Two-Opening Steam Platen Press working at a hydraulic pressure of 2500 lb. per sq. in. Platen area is 50" x 50", with a 15" stroke on the 26" ram. Under full pressure, the plates remain parallel within .003".

One of a series of HydroElectric Presses, especially developed by R. D. Wood Co. for combined matrix-forming and vulcanizing in the rubberprinting-plate industry. Its moving platen guides are adjustable in both directions. Deflection and plate-parallelism are held within .002". Plates may be heated by steam or electricity.



The newest R. D. Wood type Angle Molding Press. Both moving platens are guided with extreme accuracy, and all ram packings are easily accessible. This press is equipped with rams made of close-grained chrome-nickel iron, chromium-plated.



## R. D. WOOD CO.

400 CHESTNUT STREET, PHILADELPHIA, PA.



Vertical milling and die sinking machine in use on die blocks. (Photo courtesy Reed-Prentice Corp.)

(Continued from page 246)

#### Finishing equipment

Molded pieces as they come from the press have a fin or over-flow which must be removed. For this operation, small pieces are usually placed in tumbling barrels constructed of wire mesh and as the barrel revolves the pieces scrape against each other until the fins are broken off and drop through the screen. After the fins have been removed, the pieces are transferred to another tumbling barrel and allowed to roll together with a quantity of pegs, which have been treated with a polishing compound, to give them a high luster. The time required for this operation depends upon the condition of the molded piece as it comes from the press and the ultimate finish desired.

Large molded pieces and irregularly shaped parts require different methods of finishing and this work is generally performed by workers seated at benches. These operations may consist of hand filing with various sized files or small bench lathes, or the fins may be removed by vertical belt or horizontal belt sanders, or disk sanders depending upon the shape of the piece. A punch press or small drilling press must be available for reaming or removing flash from holes or slots to be opened.

After the flash or fin has been removed, it is often necessary to polish the surface of the piece and buffing wheels of muslin or similar soft material should be provided for this purpose. The use of two buffing wheels gives the best results, one treated with a polishing compound for the preliminary whirl and the other used dry to heighten the luster of the molded piece. Proper dust collecting facilities are, of course, required on all dust producing finishing operations such as sanding, polishing, etc.

#### Inspection equipment

The inspection department must be equipped with a complete set of precision instruments, such as micrometers and calipers for accurate gaging of parts to be assembled with others into a finished object. Occasionally block gages are prepared to check special items and the average molding shop accumulates quite a collection which must be marked and stored for easy availability.

Novelty items and complete parts require less minute inspection and may consist of casual examination of several pieces at a time. Small pieces such as bottle or tube caps are sometimes inspected on moving belts. The pieces are poured into a hopper from which they are ejected onto the moving belt which passes along in front of inspectors who pick out questionable pieces or rejects. Work tables and benches of proper shape and size to be comfortable must be provided for workers engaged in inspecting the various articles.

#### Packing equipment

Where small parts are produced in great volume, an accurate counting scale should be included in packing room equipment. Such a scale determines the number of parts by weight and saves considerable time that might otherwise be devoted to hand counting. Aside from this, the packing room of a molding shop is similar to any other shipping department, with sufficient bench space for efficient packing, a miscellaneous line of cartons and packing cases, sealing machines for tape or stitching machines for making up cartons.

#### Tool shop equipment

Each molding shop should have facilities for repairing molds or machinery and the minimum requirements for such a shop would be several bench lathes, an ordinary lathe with about a 14 in. swing, vertical milling machines, surface grinders, tool grinders, hack saws, wax cabinets, and an assortment of punches and drills, large and small. Molders who make their own dies must maintain a complete drafting room and machine shop manned by experts in the art of mold making. Planers, shapers, hobbing presses and duplicators are required in addition to lathes, drills and the usual equipment.

In addition to all this equipment and perhaps more that may have been overlooked, each molding shop must give thought and consideration to the comfort and well being of its workmen. Lighting is particularly important all over the shop with special emphasis in the inspection department and the molding room. Some shops concentrate on intensive overhead lighting, while others install individual drop lights which can be adjusted to suit the requirements of each worker. The temperature of the molding room should be controlled as far as possible for comfortable working conditions and adequate ventilation provided in every section of the shop. Air conditioning has appeared in but few molding plants at the present time, but there is no doubt that in due time all molding plants will be so equipped.

# COMPLETELY AUTOMATIC MOLDING

## *is here!*

The completely automatic molding machine is ready for your inspection. It has been used in commercial production for more than a year and one-half. Has molded thousands of parts, of various sizes and forms. Has conclusively demonstrated that automatic methods can be successfully applied and automatic production economies can be brought to the molding of thermo-setting resinoids.

It is a fully protected, fool-proof machine, requiring no operating attention, that may safely be kept in continuous production 24 hours a day and 7 days a week.

This machine will be publicly shown for the first time at the Chemical Industries Exhibition, Grand Central Palace, New York City, the week of December 6th to 11th. Prior to that time it may be seen in operation at our plant in Philadelphia. Illustrated, descriptive folder, with specifications and other details, is now ready for distribution, and we invite you to send for a copy.

*Illustrated at right:*

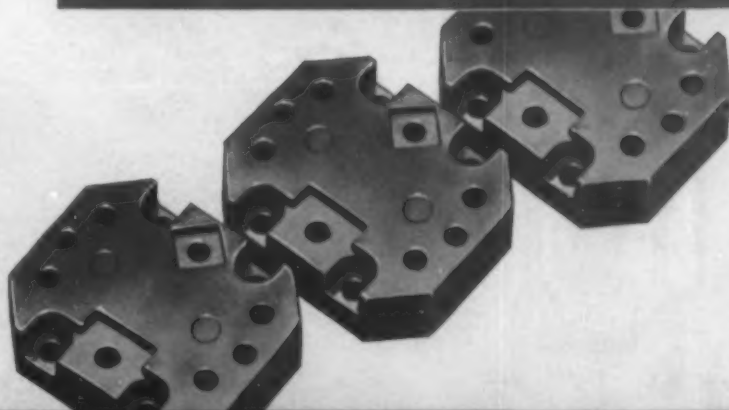
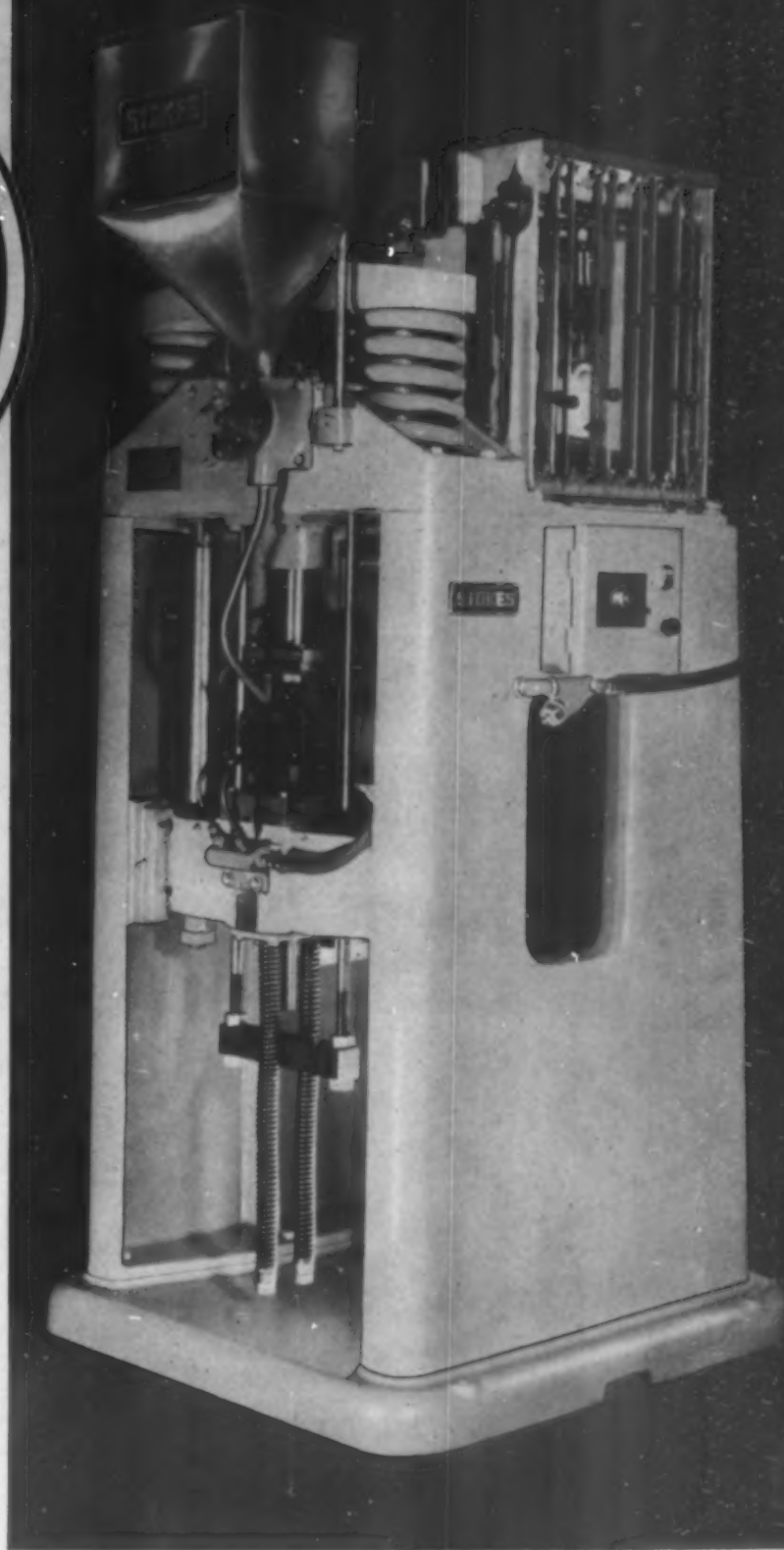
STOKES NO. 200 COMPLETELY AUTOMATIC  
PLASTICS MOLDING MACHINE

F. J. STOKES MACHINE COMPANY

3934 Taber Road

Olney P. O.

Philadelphia, Pa.



# *F. J. Stokes*

## MOLDING EQUIPMENT



# ELMES -- CHICAGO

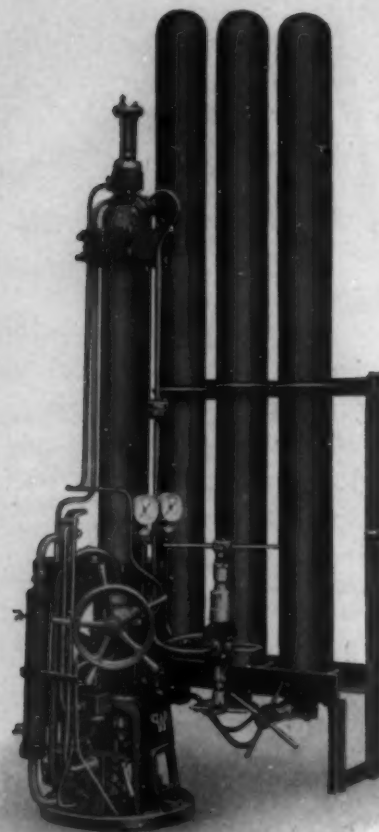
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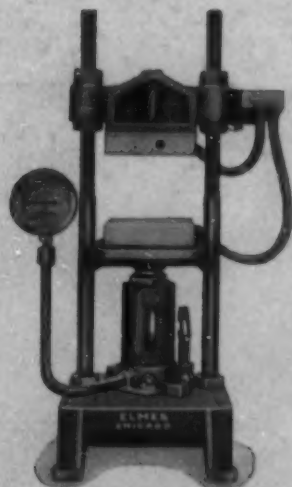
MODERN LINE  
MEETS EXACTING



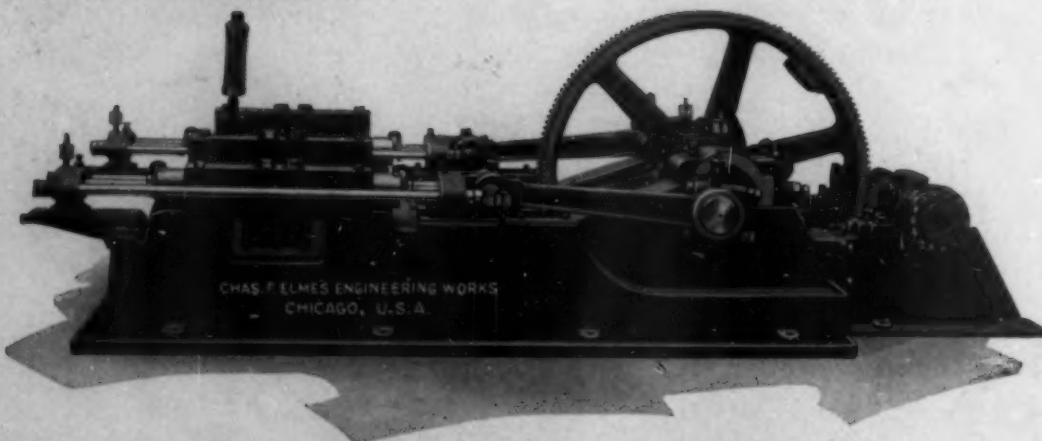
SLAB-SIDE MULTIPLE OPENING HOT PLATE PRESS



AIR BALLASTED ACCUMULATOR  
ESPECIALLY SUITED FOR  
PLASTIC MOULDING



LABORATORY PRESS FOR  
PLASTIC MOLDING TESTS



(Illustration No. 1722.) FOUR PLUNGER 8" or 12" STROKE PUMP  
DESIGNED FOR HEAVY DUTY

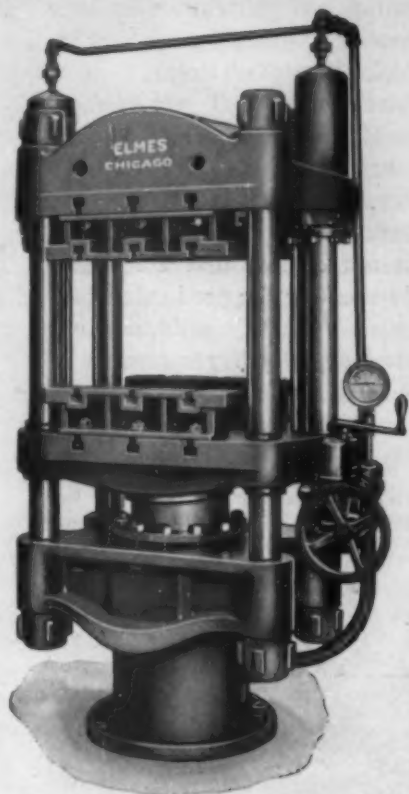
CHARLES F. ELMES ENGINEERING WORKS

# ELMES -- CHICAGO

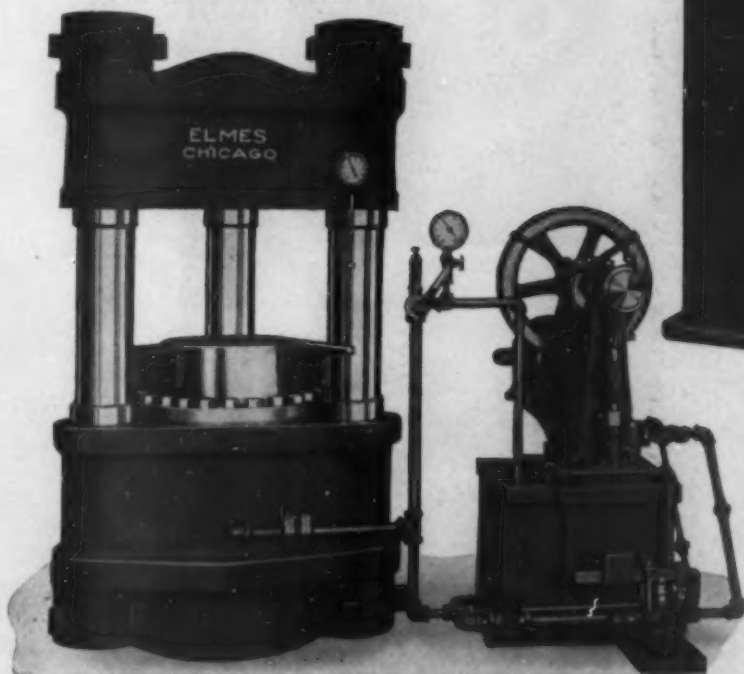
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OF HYDRAULICS  
MOULDING DEMANDS



4-COLUMN TYPE  
SEMI-AUTOMATIC PRESS



DIE SINKING PRESS & DUAL PRESSURE PUMP



MODEL 4695  
FULLY SELF-CONTAINED SEMI-AUTOMATIC PRESS  
*Built in several sizes*  
WITH TIME CYCLE CONTROL  
LATEST DESIGN—CABINET TYPE

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## INJECTION MOLDING MACHINES

(Continued from page 211) ated machines wherever possible. In cases where inserts come into the picture we recommend cycle control to regulate as far as possible a uniform production and partially eliminate the human element from the operation.

As has been pointed out in previous articles on this subject, the use of injection molding machines abroad has been confined to the molding of small castings such as buttons, small combs, belt buckles, costume jewelry and cosmetic containers, and the production has not necessitated construction of heavy duty machines.

With the advent of injection molding equipment in this country, the demand for castings made by the injection method has been increasing at an abnormal rate, and this demand has been for larger and larger castings whose ultimate uses were for industrial applications. This demand has introduced a great many problems which had to be met by both material manufacturers and the builders of injection molding machines.

The only machines available at first were those of small capacity, lightly constructed and not adaptable to the unusual demands made of them. Yet, in spite of

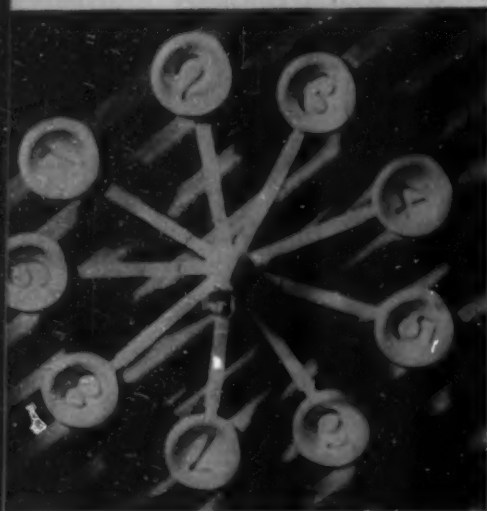
these facts, the industry has grown from approximately 75 machines in use at the close of 1935 to approximately 275 up to July 1, 1937. When we consider that the annual average consumption per machine may be conservatively estimated at 15,000 pounds of material, or a total of 4,125,000 pounds, we can readily appreciate that this comparatively new industry has played an important part in the industrial reconstruction program of the country during the past two years.

Naturally many difficulties have been encountered in keeping machines in continuous operation over long periods of time, as has been necessitated by the ever increasing demands for injection molded castings.

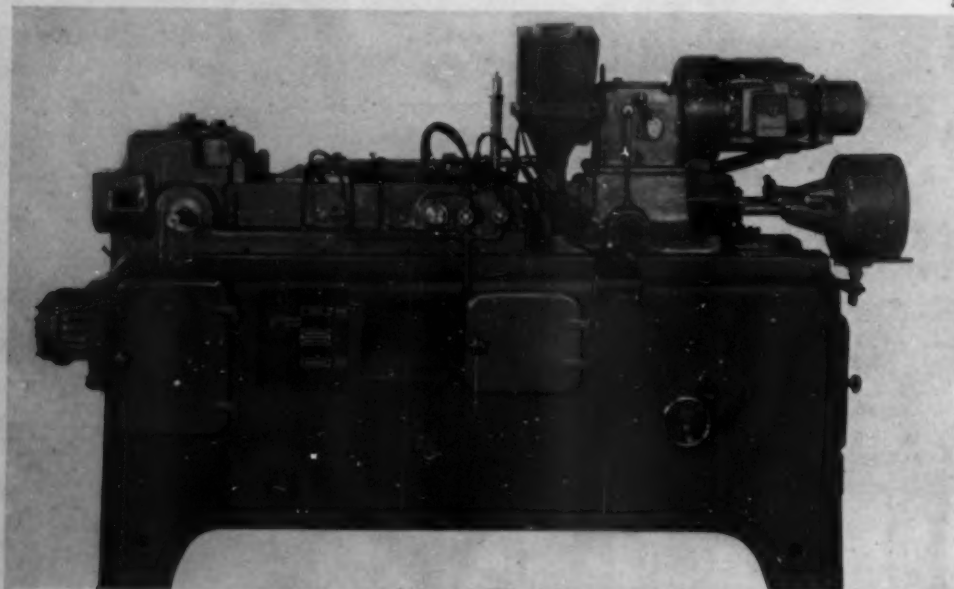
In addition to the purely mechanical problems encountered, certain material problems have presented themselves. Changes in the properties of materials, such as plasticity, heat stability, flowing characteristics, etc., have been necessary to meet the particular requirements of many castings. It is self evident that a material which can be successfully used for the production of a small, simple casting in a small capacity mold, may not be satisfactory for the production of larger castings of irregular and more complicated design.

The proper construction of dies has also introduced

3. Mechanically driven injection molding machine, fully automatic. (Photo courtesy Index Machinery Corp.) 4. Key tips, molded nine at a time, showing flow gates attached, and novelty jewelry (5) injection molded. (Photos courtesy Celluloid Corp.) 6. Collection of injection molded industrial parts. (Photo courtesy Hoosier Lamp & Stamping Corp.)



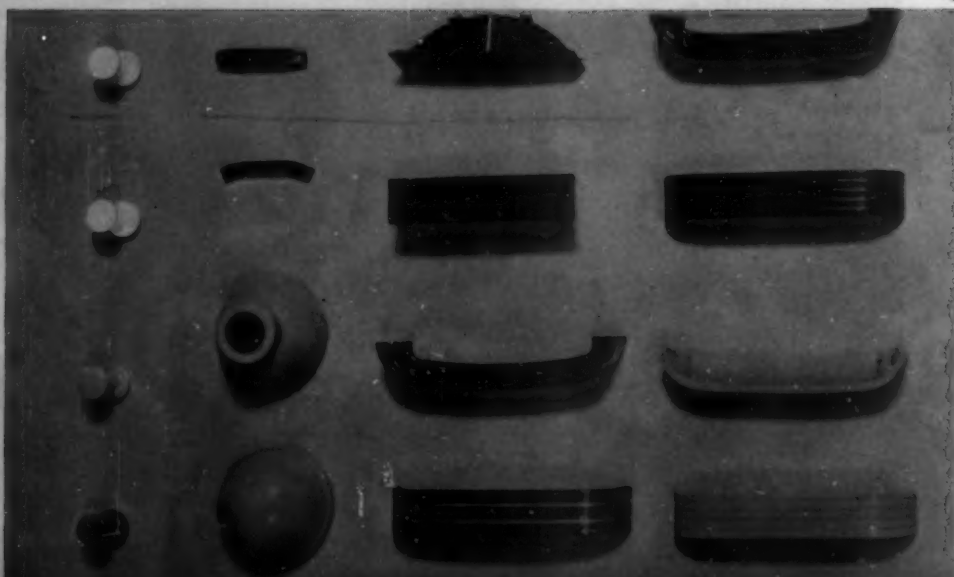
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6

## INJECTION MOLDING MACHINES

problems peculiar to injection molding. In conventional compression molding the construction of a multiple cavity die presented no more problems than a single cavity die, except the proper alignment of inserts and arrangement for proper heating and cooling of the dies. The charge of material placed in each cavity was the same whether the mold had one cavity or a hundred, and the behavior of the material in each cavity was the same. However, in an injection mold an increase in the number of cavities has introduced the problem of proper sprues.

In injection molding the entire charge for the mold is concentrated in one place and is forced through a small orifice in the nozzle, through the sprue to the interior of the mold, where it then flows through the gates to the casting cavities. Because of this, any increase in the number of cavities has introduced the problem of proper gating and arrangement of cavities to ensure filling. In single cavity molds, where relatively large and complicated castings are involved, proper gating has been a deciding influence in the successful operation of the mold.

With increased capacity of the molds the problem of proper plasticization of the material has become of major importance, since the success or failure of a machine is dependent almost entirely upon its ability to supply the right amount of material, uniformly heated, to produce the desired plasticity, at a rate sufficient to make the operation of the machine commercially satisfactory. Naturally, this must be done without any harmful effect on the materials used.

The injection machine, to be successful, must be able to inject this mass of material into the mold in the shortest possible time to prevent setting of the material in one part of the mold before the mold is entirely filled. Unless this is accomplished, the castings will have rough surfaces, internal stresses, etc., which will materially affect the strength and cause other defects, resulting in inferior castings.

As the sizes of castings increase these problems become more complicated. The mere fact that a casting containing a few ounces of material with a projected area of a few square inches can be successfully produced by injection molding is no criterion that a casting containing many ounces of material and a projected area of many square inches can be produced successfully from the same material in similar machines of increased capacity.

It is highly probable that, with the increase in the size of castings, materially beyond those now being produced, it will be necessary to construct special equipment to meet the particular problems involved in the molding of these castings. It will require cooperative work between the material manufacturer, the designer of injection molding equipment and the molders.

Injection molding is a new art in the plastics industry and, in spite of the short time it has been in existence, has obtained surprisingly successful results. Material manufacturers have greatly improved the injection characteristics of their materials. The manufacturers of injection molding equipment have also made many im-

## MODERN SEMI-AUTOMATIC SIDE PLATE TYPE MOLDING PRESS

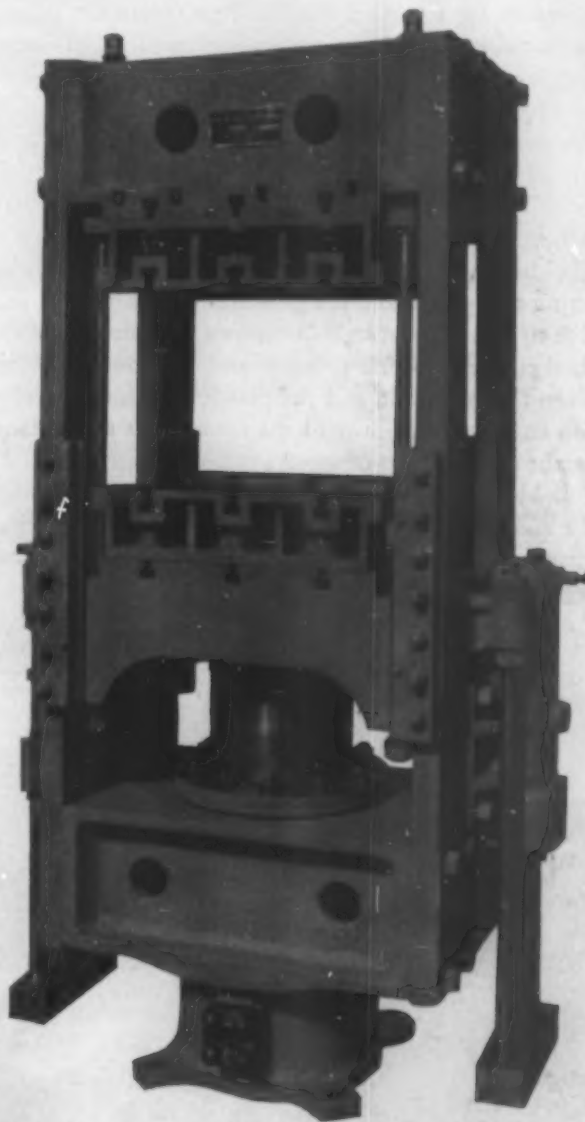
This new design has no tension rod nuts to loosen up. The side plates give the rigidity of a solid housing.

Four adjustable angular gibs afford machine tool accuracy in guiding.

With pullbacks arranged at the bottom, both sides of press are open making molds readily accessible.

Furnished with knockouts top and bottom if desired.

Write us for further particulars.



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provements; i. e., machines have been strengthened to meet the exacting production demands, and there has been a gradual increase in the capacity of the machines.

Step by step the industry moved forward during the short span of a few years; hand in hand material manufacturers, molders and equipment manufacturers have cooperatively worked in a manner that reflects credit to all who are engaged in the industry; all tried to solve the problems involved in the production of some part, and used the experience so gained to meet or anticipate the needs for the job ahead.

From the first small hand operated machine with its  $\frac{1}{2}$  ounce capacity we have moved forward by rapid strides until we are today able to secure standard machines with a capacity of 6 ounce castings per injection, and an hourly capacity of upward of 50 pounds of injected castings.

Two types of injection molding machines are now in use, the mechanical and the hydraulic. It is a safe prediction, however, to say that in the future a combination mechanical and hydraulic machine will also appear. Both types of machines have their advantages, either in performance for a certain type of work, or in the minds of the molders whose preference may depend upon their factory set up and their experience with either mechanical or hydraulic equipment.

The mechanical type of injection molding machine is simple in its operations. Two electrical motors furnish the motive power direct to the mechanism of the machines, operating both the injection pump units and the mold closing slide. A high torque motor is used on the injection pump unit and the power is transmitted to the injection piston through a spring housing, which method ensures uniform pressure and cushions the drive between the gear train and the plastic material, thereby giving an accelerated flow to the material at the instant when the combination of speed and power is so essential. The mold slide is operated by a three phase reversing motor and toggles, and a magnetic brake locks the slide on center in the closed position when the toggles are on center. Two electric time clocks control the cycles, and

the machine may be operated automatically, semi-automatically or manually.

In Fig. 3 is shown a modern mechanical injection molding machine whose capacity is  $1\frac{1}{4}$  ounces per injection and 15 pounds of castings per hour. In Figs. 4, 5 and 6 are shown the kind of work for which these machines are well adapted.

The hydraulic type of injection molding machines vary in accordance with the views of the designers regarding dimensional proportions and rigidity required for various pressures placed upon the machines. However, in principle of hydraulic application they differ but little. Figs. 7 and 8 show two types of hydraulic machines which in their turn were brought on the market to meet the demands of the molders.

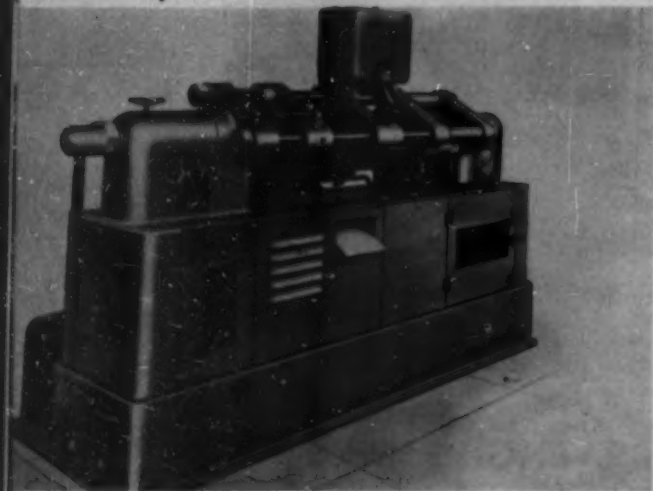
Manufacturers are constantly striving to meet the ever increasing demands for machines of larger capacity, and the hydraulic machine seems to be the answer. The machines shown in Figs. 7 and 8 in turn carried this capacity from  $1\frac{1}{4}$  ounces per injection to 2 ounces per injection, which was a step in the right direction, but increases in capacity must continue.

A larger surface area at right angles to the line of injection is the constant cry of American molders, and to meet this demand a 40 square inch area, 6 ounce capacity hydraulic machine has recently brightened the horizon and, although this size standard machine will go a long way toward meeting the demands for the regular run of injection molded articles, there will no doubt be many requests from our molder friends for special machines with greater capacity. A modern 6 ounce capacity, fully automatic and fully hydraulic machine is illustrated in Fig. 10, while Fig. 11 illustrates an article molded on this machine. These disks are  $3\frac{1}{8}$  in. in diameter with a total area of 41.2 square inches.

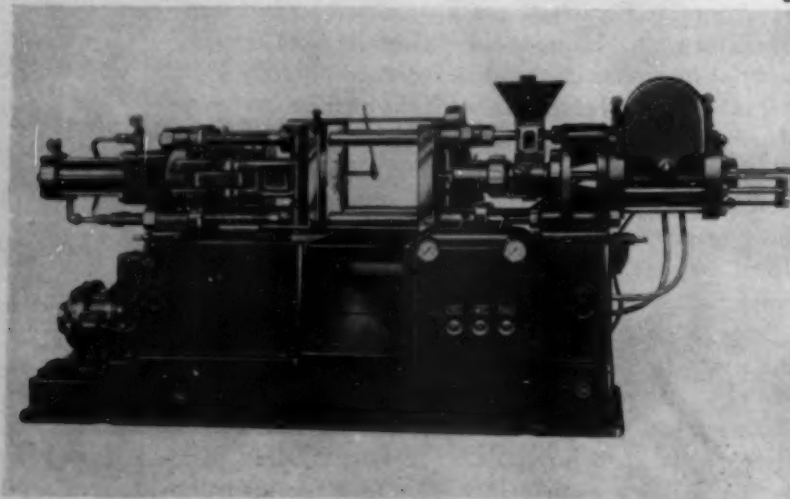
The larger capacity machine presented the all important problem of securely locking the molds under the tremendous pressures required to mold 40 square inches of area without flash. The solving of such difficulties did not stop the march of progress in injection molding, and in Fig. 12 is shown an effective means of locking the

Two of the new larger capacity injection presses, both of which are hydraulically operated.  
7. (Photo courtesy Hydraulic Press Mfg. Co.) 8. (Photo courtesy Reed-Prentice Corp.)

7



8



**NOW** . . . Synthetic plastic machinery FAR in ADVANCE of anything before!

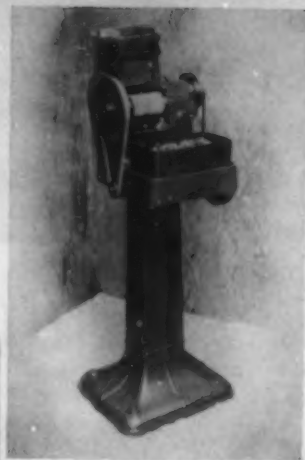
- STURDIER
- BETTER PERFORMANCE
- FASTER
- LESS LABOR

**Introducing the new ABRASIVE FORMING MACHINE**

Fully automatic!  
Patent applied for.

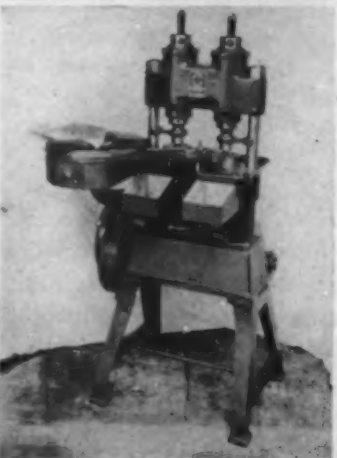
Forms balls handles and shapes, 18 line balls at a cost of 1/2 cent a gross! Fill the hopper and watch her go.

One hour's labor per day keeps her going at top production. Send for details or send your samples.



← **ABRASIVE CUT-OFF MACHINE**

For accurately cutting your largest material flat, round and angular



← **BUTTON AND BUCKLE PRESS**

A two station unit for forming and punching buttons, buckles, coasters, etc., complete with heater.

Consult us for full information about these machines or any synthetic resin working problem. No obligation, of course

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PINES ROAD NEAR PATERSON HAMBURG TURNPIKE  
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There is hardly a formula for plastic making that does not include definite temperature requirements in one or more steps of the process. In mixing, extruding, rolling and molding it is of utmost importance to exert proper temperature control.



*Taking temperature of moving roll with surface type.*



*Needle type used for temperatures within-the-mass.*

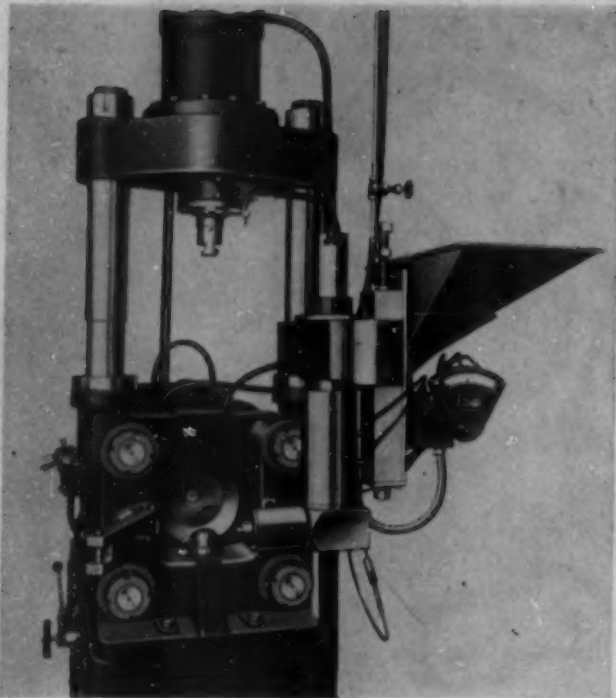
The Cambridge Pyrometer offers an accurate, quick and easy means of checking these vital temperatures . . . The needle type is for temperature taking within-the-mass, the surface type for flat and curved surfaces, and the mold type for mold cavity readings. Besides these single purpose instruments the combination pyrometer is available which has a common indicator and quickly interchangeable thermocouple attachments for the needle, surface and mold applications.

Cambridge Instrument Co., Inc.  
3732 Grand Central Terminal  
New York City

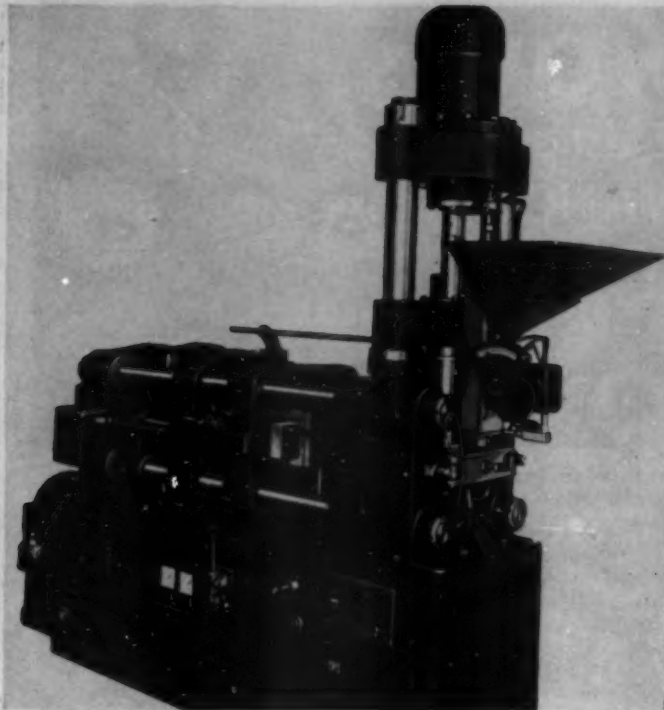
**CAMBRIDGE**  
Surface-Needle-Mold  
**PYROMETERS**

Send for the details of these instruments. They will save you money and help make better plastics.

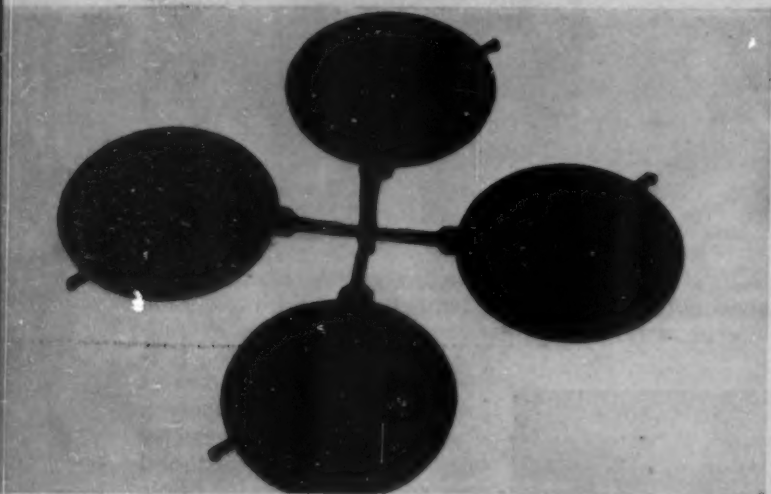
9



10



11



12



10. Six-ounce capacity fully automatic and hydraulic injection molding machine. (Photo courtesy Lester Engineering Co.) 11. Illustrates an article molded in this machine. 12. Shows how the molds are locked securely by a tapered wedge action. 9. Shows the cylinder open for quick removal or adjustment.

molds securely together by means of a tapered wedge action. The spreading of the molds under tremendous pressure is practically eliminated since it is only possible to open the molds through the elongation of the four  $3\frac{1}{4}$  in. tie bars between which the molds are mounted.

Experience has taught the molders that different kinds of materials used in injection molding had different degrees of hardness in the injection gate when the material solidified, and the injection sprue breaks off in the mouth of the die. In order to facilitate the removal of these gates it was found necessary in the newer developed machines to provide easy accessibility to the heating cylinder and injection nozzle as well as the injection bushing in the mold. Fig. 9 shows an effective means of overcoming

the difficulties; the cylinder with the injection nozzle swings clear of the machine for ready accessibility. An added advantage is the ease with which heating cylinder may be changed when changes in color are required.

As previously stated, this is not the final chapter on injection molding machines. Injection molding is frequently referred to as the Baby Industry, and it would be nothing short of folly to attempt to predict its possibilities when it is fully grown. The possibility for tremendous service lies within the realm of injection molding, and by continued whole-hearted cooperation between molders, material manufacturers and builders of injection equipment, the fondest hopes of those who are interested in its growth will be realized.



## NEW DELTA 12" DISK SANDER

For Finishing, Squaring, Plain or Compound Mitering, Fitting and Grinding on Wood, Metal, Bone, Plastics and many other materials, this new disk sander offers the same accuracy, dependability and convenience that have made Delta tools famous all over the world.

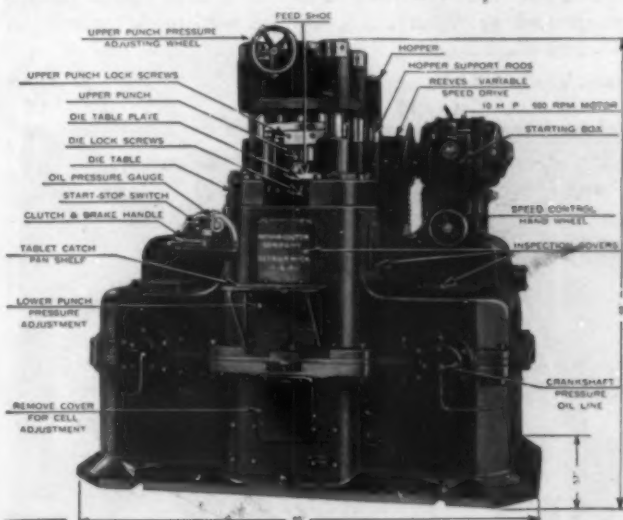
Not merely another sander, this quality tool is designed to meet every requirement for ACCURATE convenient sanding. From its specially machined, true-running 12" disk to its unusually large tilting table, its husky spindle carried on self-sealed ball bearings, this latest Delta tool is built for long life, low power consumption, accurate dependable results and maximum convenience in operations. Available in two models, Direct-drive, using the Delta  $\frac{3}{4}$  h.p. motor with disk fitted directly onto the motor shaft; Belt-Drive, for those who wish to use their own motors. Write for name of nearest Delta dealer and full details and prices.



### Belt-Driven Model

Belt drive model of new 12" Disk Sander for use in districts where odd frequently or odd voltage motors must be used. Also permits speed to be suited to individual sanding and grinding requirements.

**DELTA MFG. COMPANY**  
605 E. Vienna Ave.  
MILWAUKEE, WIS.



The finest machine of its kind... specially designed to meet the new standards of large unit molding. All working parts sealed against dust. Pressure feed oiling to all bearings. Maximum cell depth...  $3\frac{3}{4}$ ", maximum dia. round tablet...  $4\frac{1}{2}$ ". Speed 25 to 30 tablets

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### The No. 14

... 150 ton, Dual Compression  
Preforming Press

per minute. Double toggle, twin crankshafts... hence compression from *both* sides of tablet insuring uniform density throughout.

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**COLTON  
DETROIT**

## AUTOMATIC MOLDING—PART 2

(Continued from page 207)

rial. Parts of higher accuracy, delicate design and small dimensions would have a higher ratio.

Direct molding labor might account for more than 30 percent of cost and, since overhead is an important factor, these two items are of primary importance in competitive manufacturing and resulting profits. A great majority of molded jobs run into quantities of 2500 to 25,000 parts. Assume an average of 10,000 which can be extended into smaller runs, larger quantities, various material cost proportions and different capacities of molds, and let us follow a conventional cost estimate.

By conventional methods 10,000 pieces may be molded from either a single cavity or a multiple cavity mold. Assume one and six cavity molds. Cost of material  $1\frac{1}{4}\epsilon$  for a part weighing about  $1\frac{1}{2}$  ounces; many plastic molded parts are in this weight class. Maximum curing thickness of the part  $\frac{3}{16}$  inch. About 3 minutes are needed for a thorough cure or about  $4\frac{1}{4}$  minutes for a complete round or cycle, which means 14 rounds per hour, or a direct labor and overhead cost about  $8\epsilon$  a round—again the figures are average and might vary, although variations would emphasize rather than dis-

pute the point. Therefore, a single cavity mold would produce the piece at  $9\frac{1}{4}\epsilon$  and a 6 cavity mold, calling for a slightly longer cycle, would result in  $9\epsilon$  cost per round or  $1\frac{1}{2}\epsilon$  per piece, plus  $1\frac{1}{4}\epsilon$  material cost, or total  $2\frac{3}{4}\epsilon$  per piece.

Now consider mold cost. An average single cavity mold might cost \$125.00, and a six cavity mold for the same part about \$500. Prorating this cost into 10,000 pieces the final part cost will be, for a single cavity mold,  $1\frac{1}{4}\epsilon$  plus  $9\frac{1}{4}\epsilon$ , total  $10\frac{1}{2}\epsilon$ , and with 6 cavity mold,  $5\epsilon$  (prorated mold cost), plus  $2\frac{3}{4}\epsilon$  or total  $7\frac{3}{4}\epsilon$ .

With a single cavity automatic press, the mold cost remains about the same or \$125.00. The same 14 rounds will be made every hour. Material costs remain the same, and the cost of operation (electric current and compressed air) amounts to about  $1\epsilon$  per hour (at  $2\epsilon$  kilowatt-hour). Allowing 200 percent overhead, cost of automatic molding would be  $1\frac{1}{4}\epsilon$  material,  $1\frac{1}{4}\epsilon$  (prorated cost of mold), plus less than  $\frac{1}{4}\epsilon$  operating and overhead expense, or total per piece  $2\frac{3}{4}\epsilon$ . In other words, the automatic press produces parts at about  $\frac{1}{3}$  the cost by conventional methods. Ratios naturally would vary; but if the average molded piece costs triple the cost of material, the same piece molded automatically

(Continued on page 260)

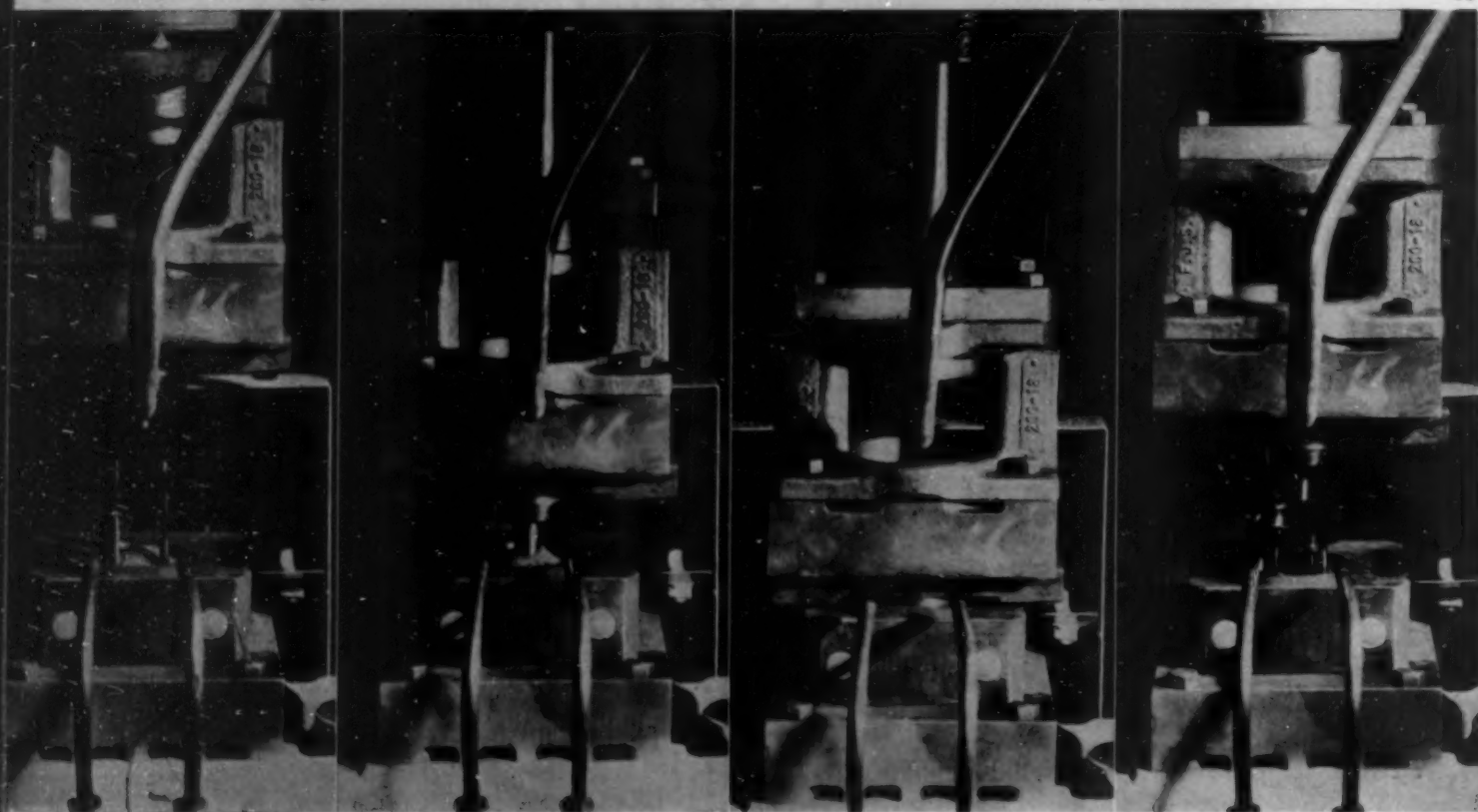
These illustrations demonstrate the four step cycle of the automatic molding press. 13. Press opens with mold ready to receive loose compound. 14. Press closes slowly and breathes (allows gas to escape) automatically. 15. Mold fully closed, remains in this position during controlled curing period. 16. Mold opens while part is removed by compressed air which also cleans the mold ready for refilling.

13

14

15

16



## New Economies for Plastic Molders

### STANDARD Self-Contained MOLDING PRESSES

No. 1 One Press—A Wide Range of Pressures

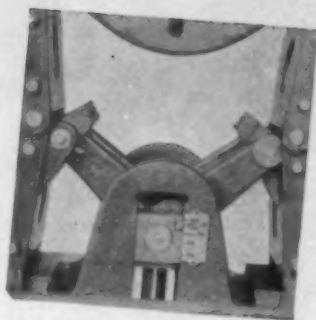
One simple adjustment—either at the high pressure pump release valve for continuous maintenance of pressure—or lowering the "Thrust" block—reduces the total rated capacity of a Standard Self-Contained Molding Press by approximately one-third. This means a Standard Press rated at 150 tons can do work only requiring 50 tons pressure.

Such flexibility is ideal for custom molders or molders doing work requiring a wide range of pressures. Capital investment is lower too, because a Standard Self-Contained Molding Press has a wider pressure range . . . therefore has a wider work range.

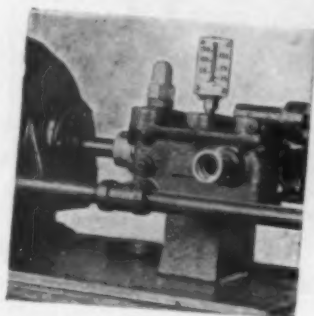
50—100—150—300 Tons

"Standard Since 1875"

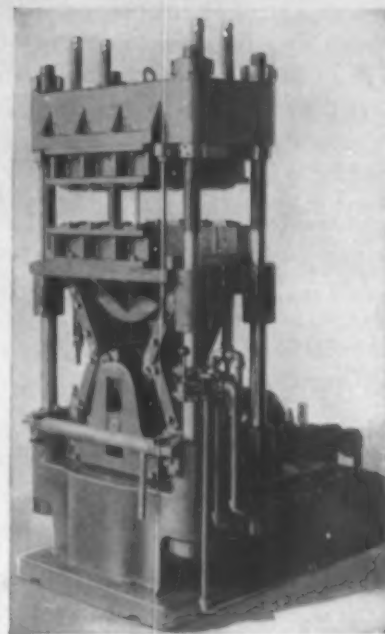
THE STANDARD MACHINERY CO.  
116 Water St., Mystic, Conn.



Indicator and Pressure Scale for adjusting pressure at "Thrust" Block.



Indicator for adjusting pressure at high pressure pump release valve.

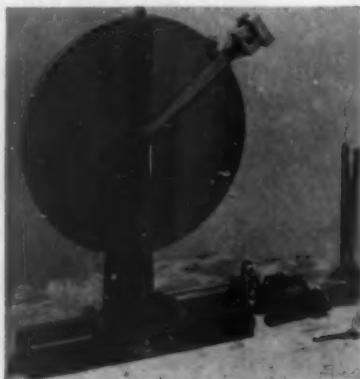


This is one of a series of advertisements explaining why Standard Self-Contained Molding Presses are specified by many plastic molders. Let us tell you how these presses can show you new ways to efficient and economical molding. Send for new folder.

## STANDARD THROUGH THE YEARS



OLSEN STIFFNESS TESTER



OLSEN IMPACT TESTER

The Olsen Tour-Marshall Stiffness Testers are outstanding machines for making rapid production, control and acceptance tests on all types of plastic sheets, rods, tubing, etc.

Write for the new 12-page bulletin describing this instrument. You need this equipment.

This Combined Charpy and Izod Impact, designed especially for the Plastic Industry, has won high praise from present users.

Our Catalog Part H gives complete information on this equipment besides other machines for the Plastic Industry.

**TINIUS OLSEN**

*Testing Machines*

500 N. 12TH ST. PHILA., PA.

OCTOBER 1937

259

would exceed the cost of material only by 10-15 percent. Actual experience has shown profits exceeding 300 percent, in some cases, above 500 percent. It is understood that such a striking comparison applies only to the parts well suited to automatic molding. A large portion cannot be subjected to such estimates and remain fully outside of the scope of automatic molding.

A tabulation of costs per piece, as arrived at above, would be as follows:

|   | One Cavity Mold                | Six Cavity Mold               | Automatic Molding             |
|---|--------------------------------|-------------------------------|-------------------------------|
| Material cost                                 | 1 <sup>1</sup> / <sub>4</sub>  | 1 <sup>1</sup> / <sub>4</sub> | 1 <sup>1</sup> / <sub>4</sub> |
| Operating cost (including labor and overhead) | 8                              | 1 <sup>1</sup> / <sub>2</sub> | 1 <sup>1</sup> / <sub>4</sub> |
| Mold cost                                     | 1 <sup>1</sup> / <sub>4</sub>  | 5                             | 1 <sup>1</sup> / <sub>4</sub> |
| Total (per piece)                             | 10 <sup>1</sup> / <sub>4</sub> | 7 <sup>3</sup> / <sub>4</sub> | 2 <sup>3</sup> / <sub>4</sub> |

There are decided advantages outside of labor cost in using single cavity molds. One of these is in the earlier initial deliveries, usually an important factor, that can be made with automatic molding.

Let us take again our single cavity mold that costs \$125.00 and probably involves 30 hours of direct labor in making, including designing and heat-treatment. It would require about 15 days to complete the mold and start production. The completely automatic press, operating 24 hours a day (no supervision is required) would produce 340 pieces per day or complete the order of 10,000 in about 30 days, a total of 45 days from date of the order. Presumably the same time would be required for conventional single cavity molding, provided three shifts are maintained; recess periods have to be deducted.

A six cavity mold, costing \$500.00, would call for about 200 hours of direct labor and would require about 5<sup>1</sup>/<sub>2</sub> weeks to design and construct. Assuming again three shift basis (thus giving all benefits to conventional molding) about 6 working days will be needed to mold 10,000 parts (at the rate of about 80 per hour), or the order will be completed in about the same period of 45 days (5<sup>1</sup>/<sub>2</sub> weeks plus 6 days). Initial delivery in case of a single cavity mold starts after 15 days and with a 6 cavity mold after 38 days. Of course, longer runs will give the advantage to the multiple cavity mold, shorter runs correspondingly to a single cavity, but the important initial delivery will stay with a single cavity.

There is a shortage of skilled labor throughout all industry, greater or less in the various trades, and really serious in some. This condition is a factor to be considered in any broad planning for future development in the field of plastics. Die and tool makers are not now available unless such individuals, for reasons that may seem good and sufficient, choose to quit one job for another. Automatic molding is certain to influence the labor situation and should be an important factor in the continued or greater use of molded products.

Die or tool makers are the mechanics who construct tools and molds for plastic materials. No plastic can be molded, no molder can be employed, until the mold is made. The mold stays throughout the job. Cost and quality of parts basically depend on its execution. Very few molds are "too good." Too often "saving"

on the mold is the curse of the job throughout its life.

High pressures required in molding plastics, workmanship, finish of cavity, all reflect on molded pieces to a minute detail of mold impression. This calls for high-grade steel and first-class mechanical skill to produce correct and satisfactory molds. Yet very rarely are molds used to full advantage. The small percentage of "mold usage" is amazing.

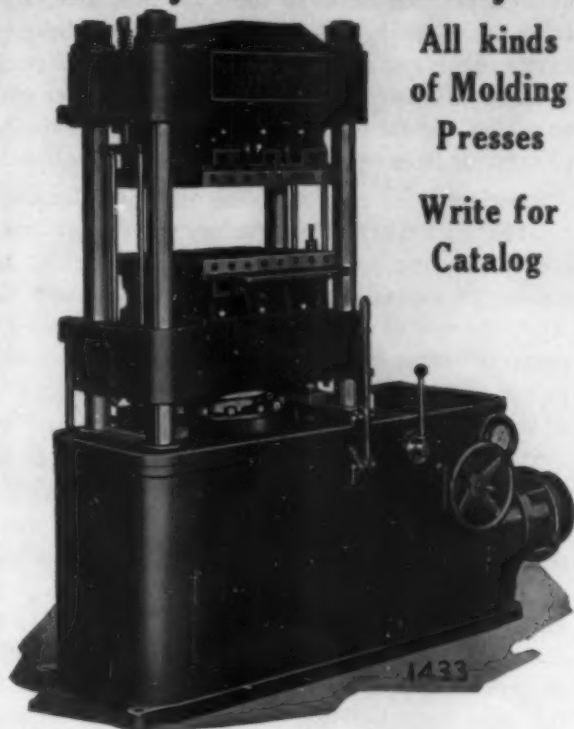
Steels used would withstand hundreds of thousands, if not more, impressions or rounds, yet molds are frequently discarded after a few thousand impressions because their required production is completed. A single cavity mold is rarely used when more than a couple thousand parts are molded. Correspondingly, 8 or 10 cavity molds are normally used in no more than 25,000 piece runs, etc. Yet millions of parts can be produced from many molds with even a few cavities. Molds are made with a multiplicity of cavities to reduce the labor cost per piece by producing more pieces per round or cycle. Consequently, a great majority of parts carry very inefficient cavity or mold costs. For instance—if a mold with one cavity, costing \$100.00, can produce 250,000 pieces the mold cost per piece is only .04¢, or 25 pieces are produced per each cent of mold cost. If a mold with 25 cavities, costing \$1250.00, is used for the same quantity (which is average usage) the cost of mold per piece is .5¢, or only two pieces are produced per each cent of mold cost. If, because of completed production, a mold is discarded after 10,000 rounds, as often happens, the mold is used only to the extent of 4 percent of its life. This waste results primarily from the necessity to minimize the cost of molding labor per piece. It is peculiar and unfortunate that molds produced by highly skilled mold makers are used to such a small degree.

There are very few men being trained as mold makers, notwithstanding the fact there are no skilled unemployed workers; these skilled men are available only by taking or inducing them from their present jobs. Yet molders or finishers of molded parts can be readily obtained from a large class of semi-skilled or unskilled unemployed. Molders can be trained in a few weeks and often in a few days; but several years are considered barely sufficient to go through a proper course of apprenticeship for a first-class mold maker.

If we can get around the necessity to construct and use multiple cavity molds, a manufacturer can be much more economical with his mold making personnel. Since only a more or less fixed number of mold makers are available within any molding company, it is advantageous to obtain the maximum results of their work. If there is a group, say, of 10 molders, their employer has at his disposal a total of about 20,000 hours per year. If we assume that an average cavity, with associated mounting and assembly, requires 40 hours of the mold maker's time for construction, then the employer can produce about 500 cavities per year.

If average molds contain five cavities, then about 100 molds can be produced a year, or 100 different parts can be molded. Such an average mold would be in operation probably only two months that year. (Figures might

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All kinds  
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Presses

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Catalog

Self-Contained Molding Press, Patent Pending  
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Piqua, Ohio

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Constructed on the lines of a power press, our Toggle Press fills the gap between the small hand lever press and the large power press. It will take a great majority of the work that is done in a large power press, such as one operation dies for brush back shells, trays, buttons, buckles, etc.

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The three end handle drills listed here are ideal for highly specialized production and general manufacturing work.

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The side handle drills listed here are ideal for drilling in all types of composition material. Equipped with HoleSaws they will cut clean round holes in thin material up to 3 1/2 inches.



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### SANDERS



Reduce operating time and produce smoother surfaces on all types of sanding.

- 7" Junior Sander**—for intermittent service—Price, \$39.50
- 7" Special Sander**—amply powered and constructed for production service..... Price, \$53.00
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Complete line of grinders for all types of grinding, buffing and polishing of large and odd-shaped pieces.

- 4" Portable Grinder**—with 4" x 3/4" x 1/2" grinding wheel..... Price, \$62.00
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- 6" Portable Grinder**—illustrated—with 6" x 1" x 5/8" grinding wheel..... Price, \$100.00

All above tools powered by Universal Motors operating on A.C. or D.C.

**The BLACK & DECKER MFG. CO., Towson, Md.**

vary, although they are based on actual experience and the point to be proved remains.) If only single cavity molds are made (again considering only mold-making facilities) then 500 different articles or parts can be molded. By operating these cavities continually for ten months of the year, the same output will be obtained as with five cavity molds operating two months.

Of course, there may be objections raised as to the advantage of small, continuous daily output, such as seasonal requirements, demands for high daily production, lack of sufficiently small presses, etc. All these objections, except possibly high daily production, are met by the fully automatic press with its single cavity mold. Continuous 24 hour daily operation, equivalent to three cavities, one shift molds, low operating cost, prompt initial delivery and elimination of cavity differences, combined with high efficiency of mold usage, emphasize the advantages of automatic molding. The necessity for more efficient use of the definitely limited output of mold makers, gives the single cavity mold a pronounced advantage, and the adoption of single cavity molds practically necessitates the use of automatic molding methods.

A great variety of molded parts, particularly those used in technical applications, such as cases for precision instruments, large moldings in business machines, some component parts in regulators and engineering accessories still require all of the elaborate equipment of conventional molding. Such parts incorporate metal inserts, often require bulky, high impact materials, accurate loading and distribution of molding compound, split and composite molds, etc., and would not economically justify methods discussed there. Yet there are countless smaller, simpler parts used in novelties and domestic articles, by the radio and electrical industries and in other fields requiring insulation or corrosion resistivity, lightness or improved appearance which can be molded automatically to advantage.

Automatic molding presses, being fully self-contained, require only connection with electric current and compressed air supply. They can be readily installed in any shop or room. No foundation is required and the operation is practically noiseless (except light periodic blasts of air). Involving no blows, or objectionable fumes or odors, such a press can be used in any shop or locality. It is a complete, fool-proof molding plant in itself, requiring no steam supply or other accessory equipment, that may be successfully operated 24 hours a day and 7 days a week. The press is comparatively low-cost and should be a profitable investment, not only for the professional molder, but for any manufacturer using or desiring to use molded parts, unless they are too large and complex.

Operating a single cavity mold day and night, continuously, makes it suitable for long as well as short runs. Assuming the part requires about  $2\frac{1}{2}$  to  $2\frac{3}{4}$  minutes for curing, or 3 minutes for the complete round or cycle, on a basis of 300 days a year, a single press will produce about 145,000 molded parts a year.

Manufacturers who might profitably use plastics

sometimes hesitate to adopt these materials because of high initial cost of changes. They hesitate to make changes because molds or tools are expensive, and mistakes are costly. With comparatively cheap single cavity molds and completely automatic presses operating at extremely low cost, there should be a great tendency to widen the use of plastics and thus lower the cost of changes or improvements in products through redesign.

Plastic molded parts are often ordered in large quantities to reduce cost. This involves stock room problems, cost of storing parts for future requirements, and an outlay of capital for parts not immediately needed. Also, the cost of molded parts as usually supplied incorporates charges for operations outside those of molding proper, such as tapping, trimming, drilling, etc., all of which call for additional, immediate capital outlay.

The contract molder, equipped with automatic presses, can simplify these problems and reduce costs to his customers. He will find it profitable to make and supply parts in quantities needed for immediate use only . . . thus doing away with storage problems. He will be able to make quick change-overs in molds to supply replacement parts in small quantities or to run off small additional quantities of parts needed to meet urgent requirements. He will be able to make changes or modifications in parts at any time and at minimum cost. He will, in fact, work closely with the users of molded parts, supply parts only as production demands require, save money for his customers and, at the same time, make the molding of parts in these smaller quantities a profitable end of his own business.

As stressed previously, automatic methods cannot replace existing equipment in plants that are well adapted to mold complete lines of plastics, including large and complex parts. Automatic molding can be utilized, however, by the contract molder to add to plant capacity, lower costs on parts within its range and to enable him to take on additional, profitable work that he is now forced to refuse. In the large molding plant it may be profitably used for the preliminary work that precedes large production, to experiment with mold changes, to produce samples and to make deliveries in smaller quantities prior to the time that large output is possible. And even after a piece is in really big production the automatic press may be kept right on the job, molding parts at the lowest possible cost.

Automatic presses are new, ingenious, simple, reliable. They are safeguarded by automatic controls that make damage to machine or mold practically impossible. And they should bring to the molders and to appliance and other manufacturers economies that will greatly expand the use of plastic materials in the simple forms so well adapted to automatic production. The next steps in the further development of fully automatic molding methods will, doubtless, be the perfection of equipment to utilize multiple cavity molds and to mold simple parts in which inserts are incorporated. It would seem quite possible that both these objectives may be attained in the not too distant future.



Actual Size 5 x 3/8"

## ARTCO FLEXIBLE SHAFT MACHINE

for grinding, die and mold-finishing for removing burrs and flash for carving cast resins and for 1001 other plastic uses.

It's about 1/10 H.P. Dumore motor develops 12,000 R.P.M.... giving more power than hand machines. Balanced construction does not tire the hand. Ball Bearings...no overheating. Always runs true.

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## CLEMENTS MFG. CO.

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Chicago, Ill.

## THE MODERN MOLDING PRESS

(Continued from page 205) output delivering only the slight volume required for makeup within the system or to follow up any yield or flow of the plastic material being molded.

From the foregoing it is obvious that the pump pressure output is determined by the spring force holding the pump on stroke. Thus the working pressure may be varied by a change in the initial spring compression. This is readily accomplished usually by a hand wheel which should be located conveniently for the operator.

This basic control introduces many new operating advantages never obtainable with the old central accumulator system. The pressure is now adjustable exactly to that which each molding job requires whereas the accumulator is loaded for a definite pressure value. The pressure is held at the desired point steadily without fluctuation such as may be caused by line surges in the accumulator system. The power consumed is proportional to the pressure developed in the new system, whereas full power is always consumed in recharging an accumulator regardless of the effective work done when discharged. The new control is absolutely automatic, holding the desired pressure for repeated operations without attention. If pressure in the circuit tends to drop due to any reaction of the work, the control will automatically place the pump back on sufficient stroke to follow up this reaction and maintain the required pressure. Shocks and water hammer are readily avoided in the self-contained press. These disturbances are usually caused by sudden stopping of large volumes of water combined with the

inertia effects of weighted accumulators. With the radial pump system, regulation of volumetric displacement is the fundamental method of control and consequently there need be no excess displacement at any time, hence no cause for shock.

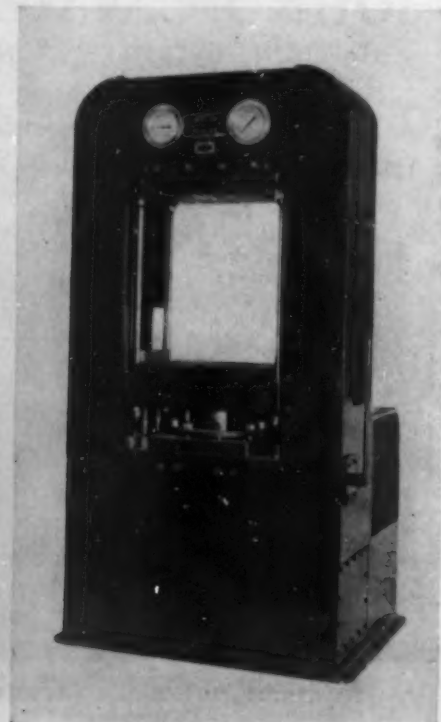
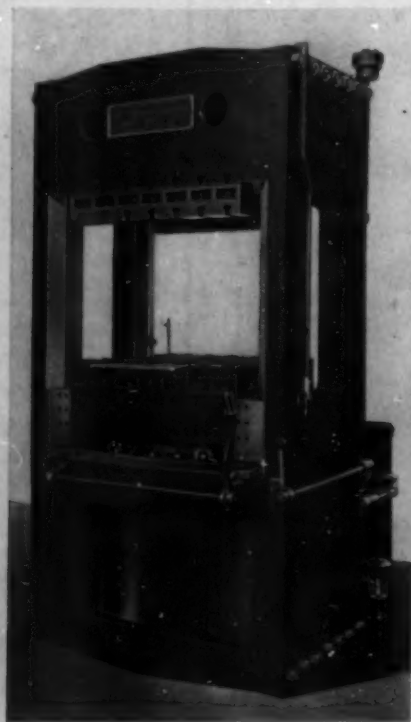
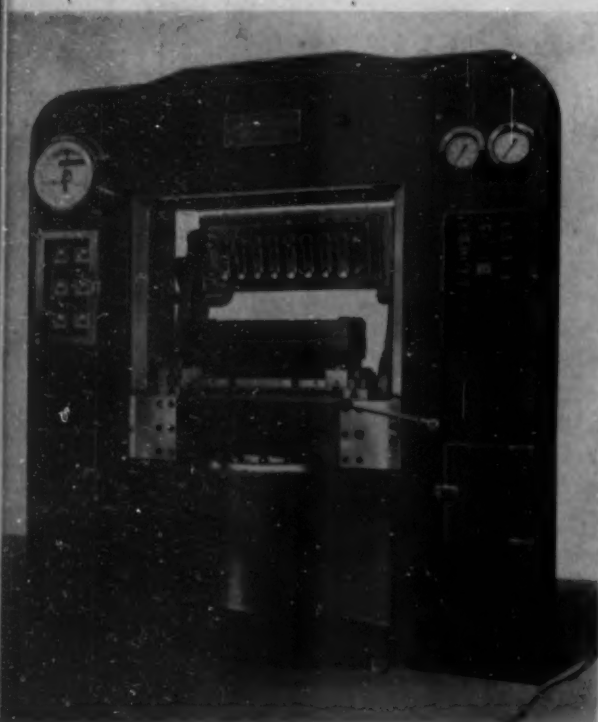
Several additional control features are available for the complete modern molding press. Among these is a second pump control adjustment for the initial pump stroke and consequently maximum volumetric displacement. Such an adjustment determines the speed of movement of the press throughout its cycle.

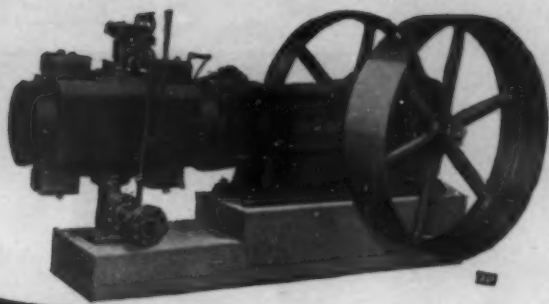
Another, and very important additional feature for plastic molding, is an adjustment for determining the rate of building up pressure on the plastic after the molds have closed. The material must be given opportunity to flux under action of heat with pressure applied gradually while the mold cavities are filling. The alternate method of accommodating this requirement is the application of first low, then high pressure from separate accumulator lines. This "Stair-Step" method means rather abrupt application of each pressure level. The self-contained method provides gradual steady increase, as up a continuous "incline," with the "slope" or rate of increase predetermined by adjustment.

Such regulation can be arranged by an auxiliary control acting on the pump stroke shifter to reduce the pump output only while the pressure is being applied to the plastic, with the normal pump output effective for all other events of the cycle.

The direction of ram movement of the self-contained press may be governed in either of two standard methods, i.e., (1) by utilizing the reversible eccentricity feature

Left—Highly developed and complete hydraulic molding press with top die mechanically operated to tilt into a nearly vertical position for cleaning and installing inserts. Center—Self-contained press with pump mounted in base. Equipped with complete automatic control of molding cycle, steam and hot water. (Both photos courtesy French Oil Mill Machinery Co.). Right—100 ton semi-automatic press with full automatic time cycle control. (Photo courtesy Chas. F. Elmes Eng. Works)





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*Bulletin 163 and other data on request.*



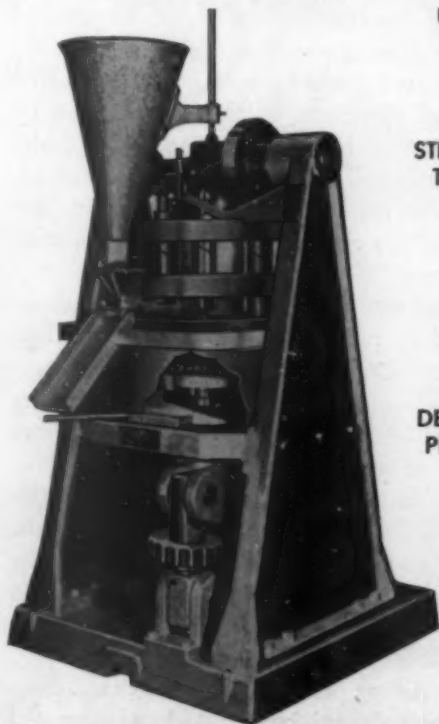
PENNSYLVANIA PUMP & COMPRESSOR CO.

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contact disc.

This price includes  
either instrument com-  
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Delivered.

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**HEAVY DUTY.** These rugged, low resistance type meters enable the use of a sturdy mechanism that will stand shop abuse. Ordinary pyrometer fragility has been eliminated. The entire housing is made of a single aluminum casting of attractive appearance—11 1/4" in length.

**ACCURATE.** The limits of accuracy of these instruments is held within 2°.

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Specify  
Catalog No. L87-C1—60°—400° F. range  
Catalog No. L88-C1—60°—800° F. range

Be sure your mould temperatures are "right." Insure your quality and your profit by preventing waste and spoilage.

Pyrometer Lances for metal melting and high temperature ranges also available.

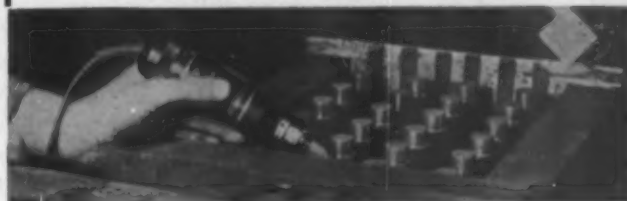
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To touch up pins on molds  
To polish dies without leaving residue  
To grind notches in a cavity mold on a set-up job  
To grind a plunger right on the press in 10 minutes  
To grind out holes in mold for brass inserts  
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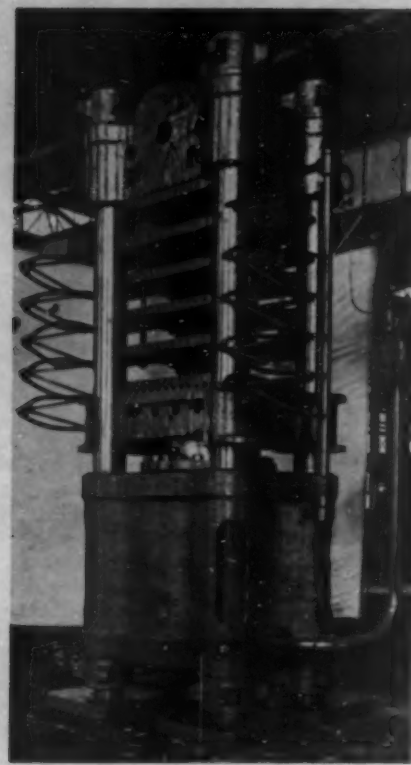
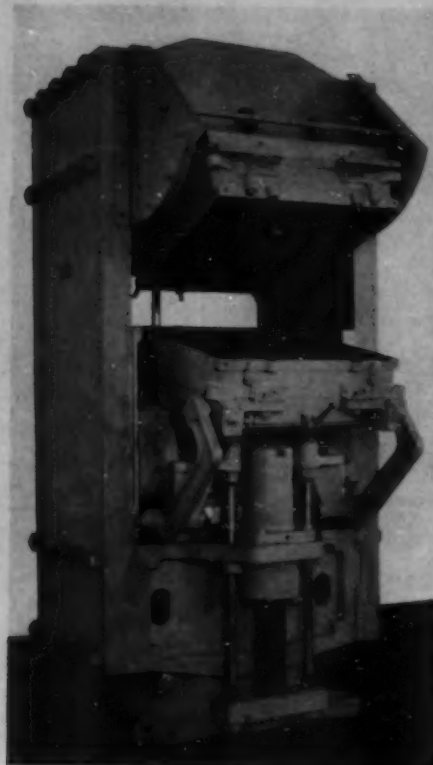
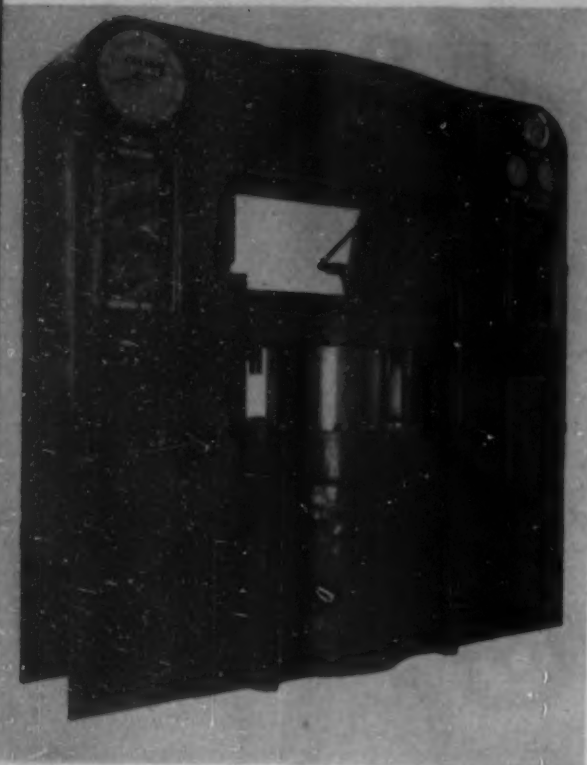
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At left—Front view of a new 330-ton tilting head molding press. (Photo courtesy Watson-Stillman Co.) Center—1000-ton automatic tilting platen press with strippers in lower platen. Equipped with adjustable angular gib guides on four corners of the moving platen. Hydraulic pressure controls the entire press action (Photo courtesy Lake Erie Engineering Co.) Right—40 by 40 in. 5-opening, 1800-ton steam platen press used for molding with Pantograph steam hose connections. (Photo courtesy Baldwin-Southwark Corp.)

of the radial pump—as previously mentioned and reversing the direction of flow or (2) by valving the pump discharge, the pump being arranged for one way delivery. The first method is used most effectively for controlling large high speed presses making a number of strokes per minute. The second method is recommended for all presses of the plastic molding class.

The press ram is arranged for double-action under hydraulic power. The full ram area is of course effective on the forward stroke for doing the molding work; a smaller ram area acting in opposition to the main provides power for opening the press, separating the molds and actuating the knockouts. This may be provided by separate auxiliary cylinders and rams or by a differential area provided by a reduced diameter on the main ram. With the latter the head of the ram is fitted with permanent pressure packing in the form of metal piston rings—separating the main and differential areas. These two sides of the press cylinder are connected via pipe lines to the reversing valve. Pump pressure is directed via this valve alternately to the forward and return ram areas, with the opposite side communicating with the exhaust.

For manual operation, the reversing valve is fitted with a hand lever. However, automatic timing is frequently desired in plastic molding to assure that a uniform curing cycle is maintained. In such cases the valve is actuated by some auxiliary source of power which in turn is governed by the timer. An electric actuator, such as a solenoid, is preferred permitting the use of an electric clock timer.

To save time, some auxiliary means of advancing the main ram in closing the molds is desirable. The most practical arrangement is an auxiliary ram of small area acting with the main ram. The full pump capacity applied to this small auxiliary will provide faster closing movement. During this travel the main ram is prefilled from the oil supply through a suction check valve.

Ejector attachments for mold knockouts are actuated either by the return movement of the main ram or by separate hydraulic rams. For the independent hydraulic ejectors a separate hydraulic circuit with a small medium pressure pump is the most practical arrangement, permitting operation at any time without interference with the main press system.

There are of course many details and refinements about the complete modern molding press which although seemingly small contribute greatly to the complete success of the operation and the user's satisfaction. Among such is the matter of pressure connections. These lines should be made up of seamless steel tubing bent to position with the minimum number of joints and fittings. The terminals should be either compression type tube fittings for the smaller lines or bolted flanges in the larger sizes. All fittings should be forged steel. No threaded pipe joints should be tolerated; instead all fittings should be smooth bored and welded in place.

Altogether the molding press which meets the various qualifications set forth above is truly a modern integrated machine, arranged to best fulfill the specialized requirements of the plastic molder.

FILTER  
PRESSES

**LOOMIS**

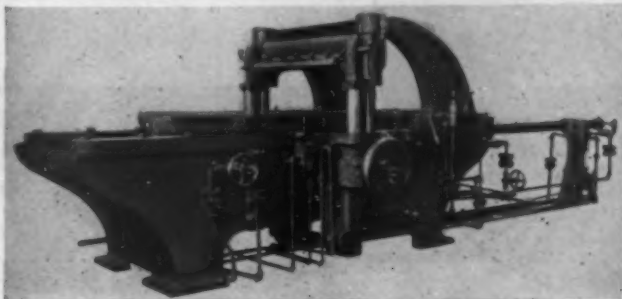
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FOR THE  
PLASTIC AND OTHER  
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Dedhydrating Presses -- Polishing Presses  
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pressure

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**Cuts Maintenance Costs  
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—YET THE INITIAL  
INVESTMENT IS NO MORE!

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But—the maintenance charges are bound to be higher on the central boiler system

on the KANE boiler press unit fuel is consumed only when the press is in service; with the central system, as presses are shut down the hourly fuel cost increases on those remaining in service and, with the KANE, only, is it possible to set up a dependable fuel cost of production for purposes of estimating.

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# VICKERS

## HYDRAULIC PUMPS AND CONTROLS

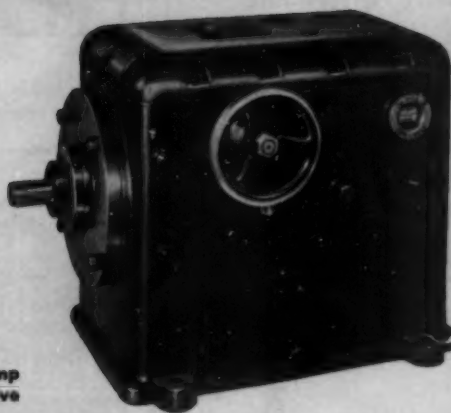
*Do a Better Job of Meeting  
the Diverse Requirements  
of Plastic Molding*

# "LIGHT OR HEAVY"



**Vickers Double Pump  
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Assemblies**

Make use of the compactness and simplicity of the Vickers Balanced Vane-Type Pump. By means of the double pump and automatic control, delivery is large in volume for low pressure requirements—low in volume for high pressure requirements.

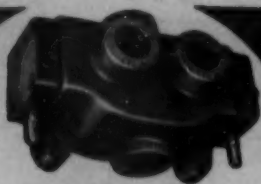


**Vickers Variable Delivery Pumps**

Varying angle between two elements changes piston stroke, hence delivery volume. Variations may be automatic, manual, cycle, or pressure controlled.

Light pressure with fast delivery to quickly open and close molds . . . heavy pressure for either slow or fast injection or final squeeze.

The plastic molding industry demands flexibility and adaptability to many working conditions. Standardized Vickers (Oil) Hydraulic Units meet these requirements efficiently, dependably, and simply . . . with minimum maintenance expense.



**Vickers Pilot Operated  
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Permit remote or automatic control when used with Vickers Pilot, Timing and Interlocking Valves.



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Provide ease of adjustment of injection pressure independent of system pressure.

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"FAST"  
or  
"SLOW"



The prospective purchaser of molding machinery is vitally interested in the hydraulic pumps and controls which he will acquire with his new machinery. Can this hydraulic equipment be easily inspected and understood by his maintenance men? Will it stand up for long service periods? Can it be inexpensively and quickly repaired after long and faithful performance?

The answer to all of these questions is, "yes" . . . when he specifies Vickers Hydraulic Equipment. In plastic molding, as in other industries where "the going is tough," Vickers Pumps, Valves and Controls have established an enviable record for long, dependable and trouble-free operation.

Makers of quality molding equipment have recognized the basically correct design features of Vickers Hydraulic Units and have proved them in service. Hence the use of Vickers equipment on molding machines such as those illustrated below is in itself an index of quality.

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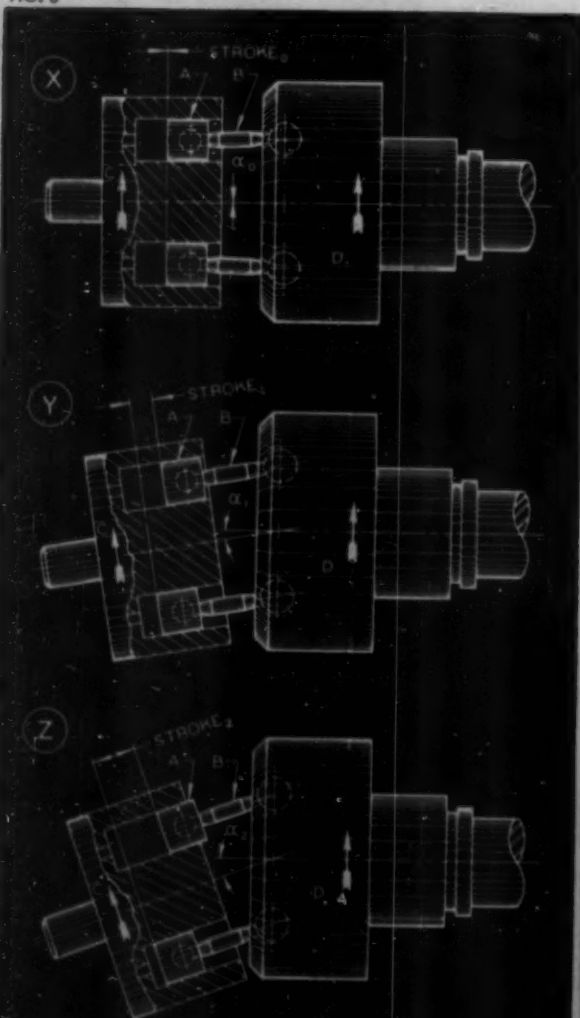
**Vickers Check Valves**  
Have hardened alloy steel internal parts, also designed for heavy duty service.



## HYDRAULIC CONTROLS

(Continued from page 219) the "constant delivery" type of pump, operating characteristics of which have been previously outlined. Oil from the large volume pump is delivered first into an "unloading valve." This valve is so designed that it may be externally adjusted to open when any given pressure occurs in the diagrammatically indicated chamber "R." When the pressure in chamber "R" is less than the pressure to which the valve is adjusted to operate, the oil flow from the large pump is directed as shown in the low pressure (left-hand) diagram. This oil continues through a check valve without appreciable resistance, and thence to a junction point at which the oil flow from the small volume pump joins it. The combined flow from both pumps then continues past the as yet inoperative overload relief valve and to the molding press or molding machine hydraulic control circuit. Assuming that the unloading valve adjustment is set at a pressure of 500 lbs. per square inch, no change in the action of the circuit in the combination valve assembly can take place until sufficient resistance to flow is encountered at the working cylinders to build up more than this amount of pressure. Therefore, a volume equal to the delivery rate of the small pump plus the delivery rate of the large pump will be available for all operations which do not require in excess of 500 lbs. per square inch oil pressure in the working cylinders.

FIG. 3



Immediately upon the occasion of a pressure rise in the discharge line to the press or molding machine, pressure also rises in the control chamber "R." When the pressure reaches 500 lbs. per sq. in., the unloading valve opens to allow a freely escaping flow of oil to the reservoir, the check valve meanwhile closes as this takes place, and the large volume pump merely circulates oil from the reservoir and then back again without appreciable resistance or work being done. During this time the small volume pump is continuing to supply the control circuit on the press or machine with oil, thereby maintaining any required pressure up to the setting of the overload relief valve. We shall say this latter valve is adjusted to operate at a pressure of 1,000 lbs. per sq. in., which being the case, the delivery rate of the small volume pump is available to perform all functions requiring hydraulic working pressures up to this maximum figure. This condition is shown schematically in the drawing for the high pressure right-hand diagram in Fig. 1. Any fluctuation of pressure during the operation of the machine has no effect whatsoever upon the unloading valve so long as the operating pressure is above the 500 lbs. per square inch setting of this valve, by reason of the fact that the unloading valve is designed to open wide at the pressure for which it has been adjusted and to remain fully open at all higher pressures. When the operating pressure drops below the unloading valve setting, however, the accompanying drop of pressure in chamber "R" closes the unloading valve and the operation reverts to the large volume, low pressure, condition depicted by the low pressure diagram. The changeover from one condition to the other is, for all practical purposes, instantaneous.

A great deal of flexibility to meet various molding requirements is provided by the double pump and combination valve assembly, as interchangeable pump parts make possible a wide selection of capacities for both the large volume and the small volume units. The operating pressure at which the automatic changeover from the large to small volume takes place is readily adjustable (unloading valve setting), and the maximum injection or holding pressure is also readily adjustable (overload relief valve setting). All variables may therefore be changed, if required. At the same time, relatively inexpensive, quiet, long life pumps of the simply constructed constant delivery type may be utilized in much the same role as that in which a variable delivery pump ordinarily has been thought necessary.

Variable delivery pumps, as differentiated from constant delivery pumps, are mechanically designed in one of several ways so that the displacement may be varied at will. Variation of this displacement is usually accomplished manually or by pressure actuated means, and re-

FIG. 4

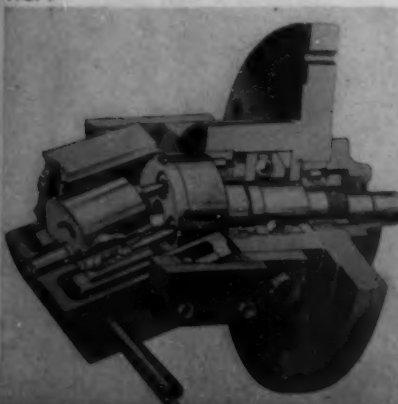
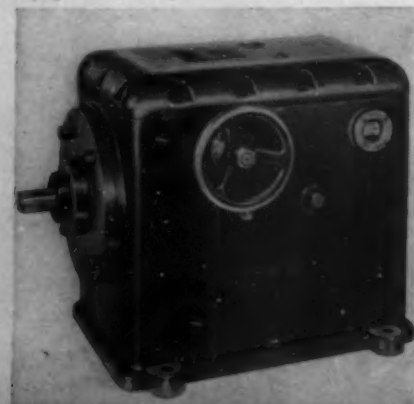
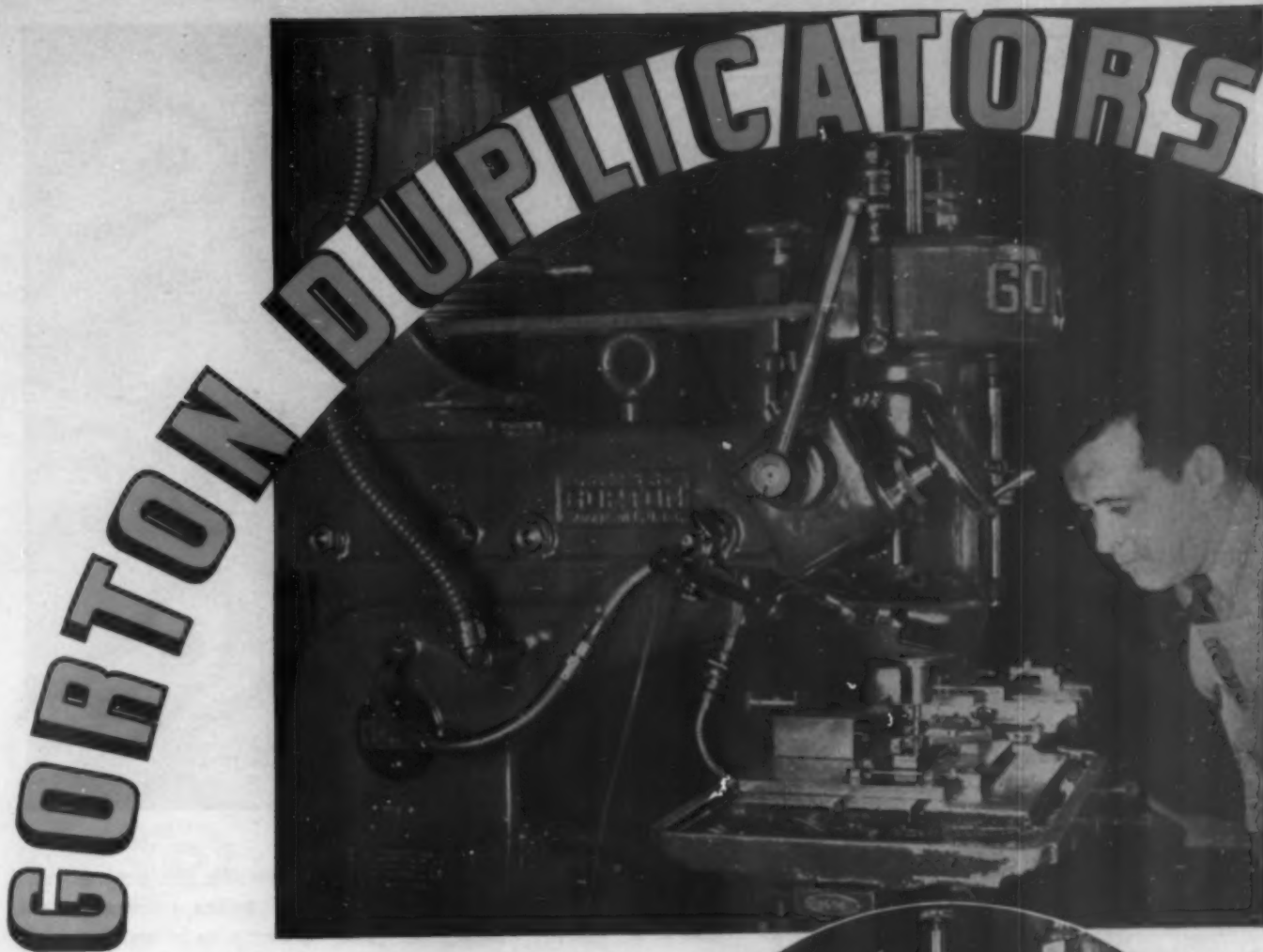


FIG. 5





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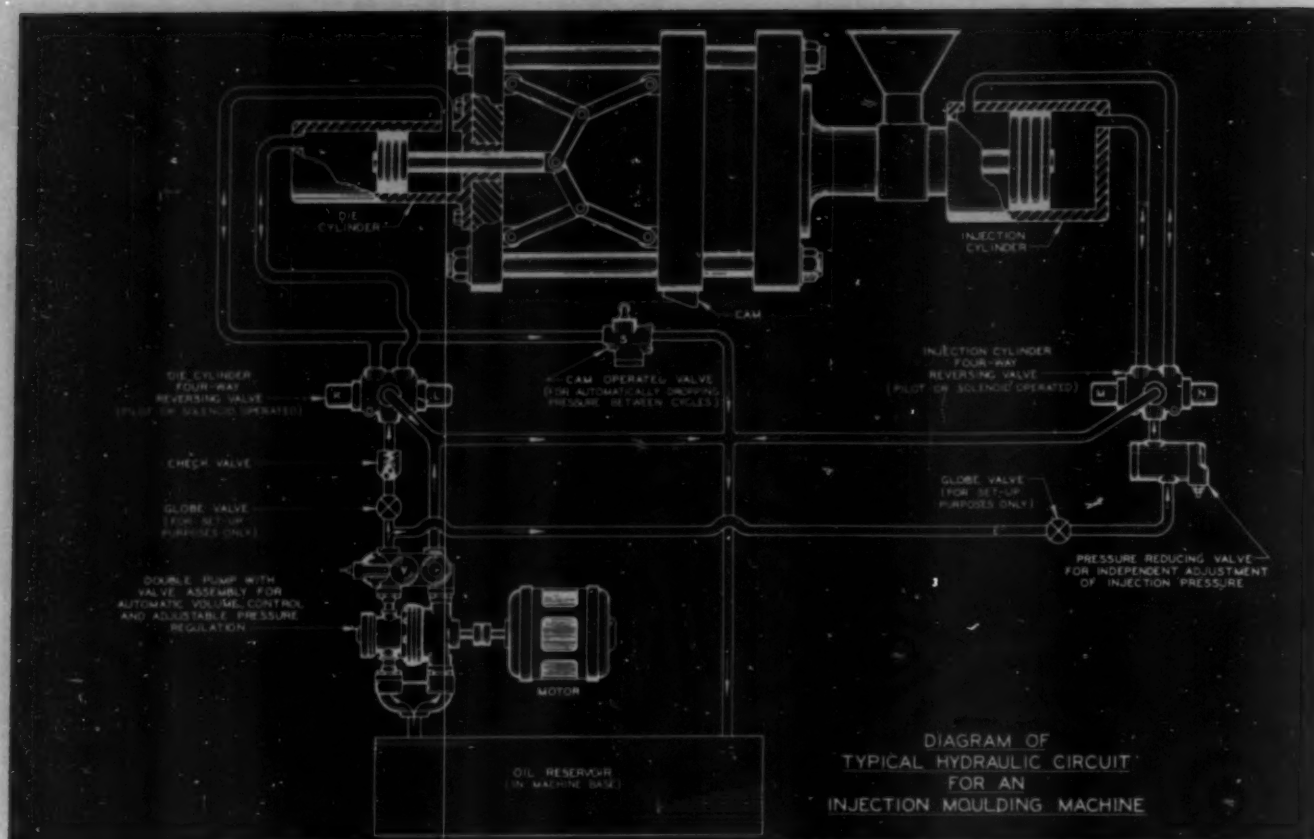


FIG. 6

sults in a proportional variation of the delivery rate of the pump while the pump drive shaft r.p.m. remains constant. Although available on the market for a considerably longer period of time than the "combination assembly" type of pump previously described, a very brief description is being offered here of one model variable delivery pump and its usage as generally adaptable to plastic molding practice. Fig. 3 has been reproduced to illustrate one easily understood design. This drawing shows only the chief operating parts of the cutaway assembly shown in Fig. 4, and is almost self-explanatory of the operating principle which is used to obtain the variable displacement action. Five or more pistons (A) and piston rods (B) are equally spaced in a circle about the pump center line, with all piston rod center lines parallel to this pump center line when the cylinder block (C) is at the zero-displacement position shown in the top drawing "X." As the rod carrier member (D) is rotated by the drive shaft, the cylinder block and pistons also are made to rotate with it. So long as the center line of (C) remains in line with the center line of (D), the pistons have no effective stroke or relative motion with the cylinder block, and as a consequence there is no resulting displacement of oil to be delivered through the valve plate and to the control circuit. However, as soon as the housing for the rotating cylinder block is moved as shown at "Y" and "Z," the stroke is increased with the angle  $\alpha$ , and the pump delivery of oil to the press is increased proportionately. This movement of the cylinder block housing is accomplished through a link and a pivoting action about two hinging trunnions (Fig. 4). The link may be operated by a hand wheel and screw, or

by a small hydraulic cylinder which can be connected with the pressure line leading to the control system, thereby causing the pump delivery to be reduced automatically as the operating pressure increases. In the latter case the pump is arranged to reach the zero-displacement position as the adjustable maximum operating pressure is attained, this automatically limiting the pressure to the desired maximum figure.

The opening and closing speed of a press operated by a variable delivery pump of this type will therefore be determined by the displacement rate of the pump at the maximum operating angle, while the maximum closing pressure can be varied by changing the setting of the pressure compensating spring governing the pump operating angle. Usually a pump of the type shown sectionally in Fig. 4 is supplied in an oil reservoir and ready for use as pictured in Fig. 5.

A number of modifications in controls are available for the variable delivery type pump. These may be used in conjunction with and in addition to the regular control system of valves on the press. The pressure actuated control just outlined probably is of greatest interest to the typical user of plastic molding machinery, however, and probably is the type with which the majority of present users are familiar.

By reason of the relatively recent widespread use of the hydraulic injection molding machine, a machine of this type has been chosen to illustrate the functioning of a typical hydraulic control circuit. Fig. 6 is a diagrammatic representation of the pump and control valve units used in such a typical circuit. The arrows indicate the direction of oil flow in the pipes, and a study of these,

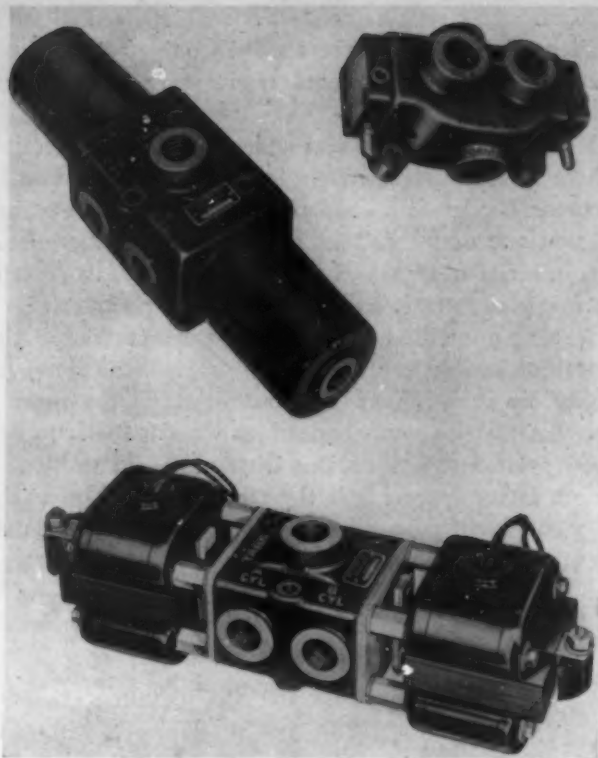


FIG. 7

together with the explanatory notes, will outline the functioning of the circuit. Action of the double pump and combination valve in the circuit has already been explained, and the action of the four-way reversing valves is easily deduced if one is not already familiar with their operation. They are shown in such a way that they may be considered as either of pilot operated type or of solenoid operated type. The end caps designated as "K," "L," "M" and "N" may therefore be thought of as housing either small hydraulically actuated pilot cylinders and pistons, or electrically operated solenoids. Whether the pilot circuit is hydraulic or electric, actuation at "L" will be assumed to cause the four-way valve to shift so that oil is introduced to the head end of the die cylinder, and the dies will therefore close. During this movement, the oil in the rod end of the cylinder is being exhausted back through the four-way and to the reservoir. The self-locking link mechanism, augmented by the check valve in the supply line, holds the dies closed while the action of the injection cylinder takes place. Timing of the injection is controlled by pilot actuation, first at "M" and then at "N," which causes the piston of the injection cylinder to move first to the left and then return to the right. Pilot actuation at "K" then follows when it is desired that the dies be opened. During this latter movement oil is supplied to the rod end of the die cylinder and is allowed to exhaust freely from the head end, thereby reversing its direction of flow in the two piping connections as compared with the conditions during the die closing operation. As the opening movement of the dies is completed, the cam shown at the bottom of the movable die plate depresses the operating plunger of the cam operated shut-off valve "S." Oil

flow which was previously being directed to the rod end of the die cylinder then is allowed to escape back to the reservoir at negligible resistance. The full pump delivery therefore is discharged between operating cycles at zero pressure. If fully automatic operation is being used and time between cycles is not required, then the cam may be retracted to make the valve "S" inoperative.

Fig. 7 is illustrative of three types of remotely controlled four-way valves which may be employed in circuits such as the one described, or, for that matter, in oil-hydraulic press circuits also. At the upper right is pictured a pilot operated four-way, which is actuated by oil introduced alternately at the small pipe connections in the end caps. Small copper tubing lines, similar to those used with central pressure lubrication systems, supply the oil to these connections from the controlling pilot valve. The latter may be operated by relatively small electrical solenoids, by hydraulic timing valves or manually by the operator. The four-way valve at the upper left of Fig. 7 is operated by completely enclosed oil cooled electrical solenoids, while the lower valve is similarly operated by external air cooled solenoids.

Each four-way valve design has certain advantages for a given set of working conditions. This, in itself, is illustrative of the flexibility possible in hydraulic installations of this type. It should be further noted, in the interests of simplicity and maintenance, that the first two described four-way valves have but one moving part.

In all oil-hydraulic systems, the fact should not be overlooked that the circulating fluid, which does the work by applying pressure where needed, is as good a lubricant as is available. Thus every working part in the system is constantly self-lubricated under pressure.

The use of good quality oils will pay handsome dividends. Some oils have a tendency to break down under sudden changes of pressure and temperature, especially when oxidizing conditions are encountered simultaneously. As oils used in hydraulic systems are always expected to remain in service for long periods of time without renewal, it will be found economical to use those oils which have favorable volatilization, oxidation, water affinity and acid characteristics. Viscosity specifications should be determined by the type of pump used. Ordinarily, the correct oil viscosity rating will be stamped upon a tag carried by the machine or press.

As any properly designed hydraulic system is thoroughly protected against dirt and grit, the maintenance problem of greatest importance is that of preventing dirt from entering the system when refilling, and of using the proper oils. These precautions are of much greater importance than is generally supposed.

Air and dirt in the oil are the two major things to guard against after a system is in operation. They are such easy things to eliminate, that their importance is sometimes overlooked until a certain amount of erratic action or worn parts result from their presence. As in many another piece of machinery, an adequate amount of clean oil of good quality is the best insurance of long trouble-free operation, once a well engineered application using properly designed hydraulic units is provided.

## FLEXIBLE METAL TUBING

(Continued from page 216) the tube with the flange fitting down into the second groove of the tube, is tightened against the body of the coupling by a nut, resulting in the compression between the flange and coupling body of the two end corrugations. The braid is gripped between the sleeve and nut.

Whether presses have series or parallel steam unit connections or large or small platen movements flexible metal hose connections are ideally suited for the work. Fig. 3 illustrates the steam travel under a series con-

FIG. 3

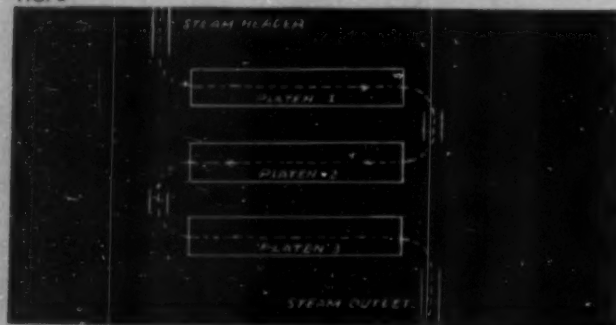


FIG. 4

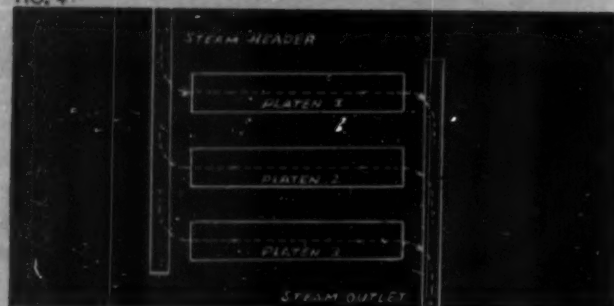


FIG. 5

nection. This type of connection effects freedom from condensation on small presses with only two or three platens. The steam pressure acts to keep the system itself clear of condensate.

Fig. 4 shows steam travel under a parallel connection where steam flows through individual platens from a common header to a common outlet. This connecting system is recommended for multiple presses where heat loss in series steam travel would be sufficient to prevent bottom platens from attaining proper temperatures.

A simple method of calculation to determine the length of flexible hose needed for either of the above installations is as follows: measure the maximum distance between platen steam connections when press is in full open position; add to this dimension the additional length factor appearing in the table below. The resulting figure is the proper overall length of flexible hose unit for efficient press operation.

ADDITIONAL LENGTH TABLE

| I. D. of Flexible Metal Hose | Additional Length Factor of Flexible Hose |
|------------------------------|---|
| 1/4 in.                      | 15 in.                                    |
| 3/8 in.                      | 16 in.                                    |
| 1/2 in.                      | 18 in.                                    |
| 3/4 in.                      | 22 in.                                    |
| 1 in.                        | 24 in.                                    |

The development of self-drain supports for flexible metal hose units has progressed in order to give engineers assurance that the steam pressure is not decreasing on the presses due to the accumulation of condensate in the tubing. Such supports are necessary where the tubing is installed on a horizontal plane and the loop is too large for the tube to entirely support. In such an instance there is a tendency for the loop to sag throwing weight and strain on the metal hose at the point where it enters the lower coupling and providing a pocket for the formation of condensate.

A simplified, flexible drain support has been perfected to meet this situation. It permits free movement of the unit at all times without allowing it to sag below the horizontal and controlling the flexing of the hose without unnecessary strain.

To aid the molder or maintenance engineer in computing the length of hose and link support necessary for the average press the three charts given as Fig. 5 have been prepared by flexible metal hose development engineers.

In an effort to speed up production a tendency to increase the size of steam connections used on platen presses above the size of inlet or outlet with which the individual press is normally equipped, has developed among molders. The theory in back of the trend is that the larger connection permits the operator to speed up the cycle of the platen press by increasing the steam capacity.

With proper installation and handling, flexible metal hose units will not only speed up the operating of platen presses but will reward the operating engineers by requiring a minimum amount of care and maintenance.

## *Too frequent Packing Replacements Seriously affect Profits*

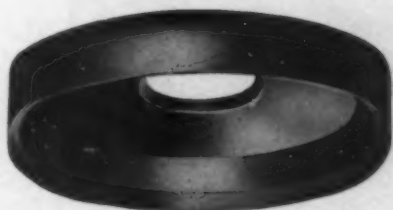


If you have ever felt that the packings in your hydraulic or pneumatic presses required too frequent replacements or leaked too much or did not give you dependable pressure, it would be well for you to try

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The dependable pressure which the Tannate Packing seal gives you facilitates the correct rate of cure, a glossy smooth finish, greater strength and fewer shrinkage dangers.



The durability of Tannate Packings, their slight wear on pistons and gland walls make them economical not only from standpoints of maintenance costs and number of replacements; but their freedom from the usual packing troubles assures greater output.

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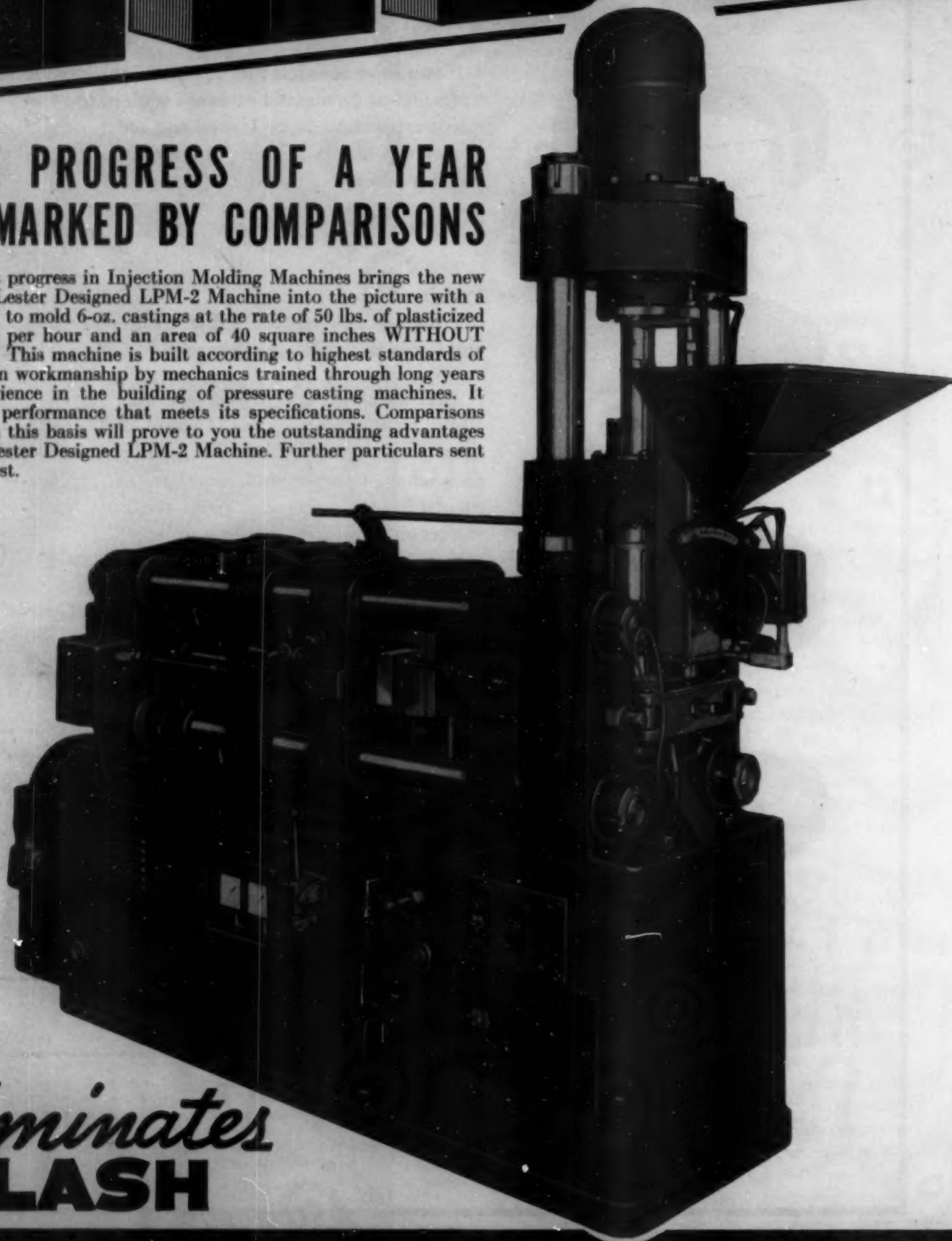
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## THE PROGRESS OF A YEAR IS MARKED BY COMPARISONS

A year's progress in Injection Molding Machines brings the new I.M.C. Lester Designed LPM-2 Machine into the picture with a capacity to mold 6-oz. castings at the rate of 50 lbs. of plasticized material per hour and an area of 40 square inches **WITHOUT FLASH**. This machine is built according to highest standards of American workmanship by mechanics trained through long years of experience in the building of pressure casting machines. It delivers performance that meets its specifications. Comparisons made on this basis will prove to you the outstanding advantages of the Lester Designed LPM-2 Machine. Further particulars sent on request.



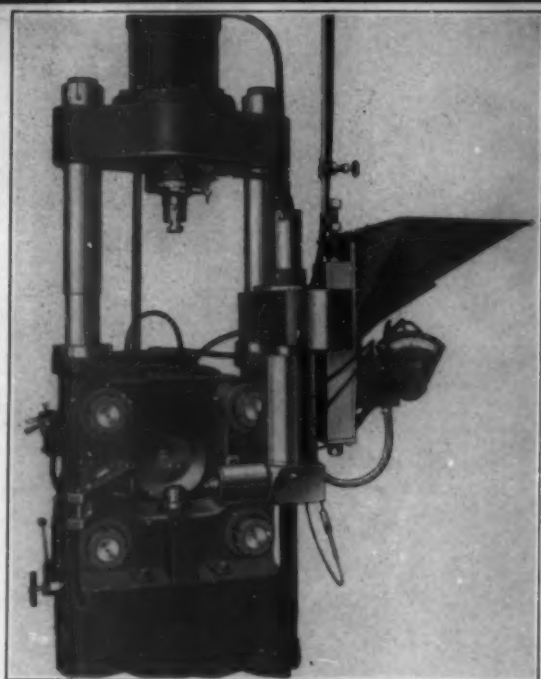
*Eliminates*  
**FLASH**

# INDEX MACHINERY CORPORATION

**DESIGNED  
LPM-2**

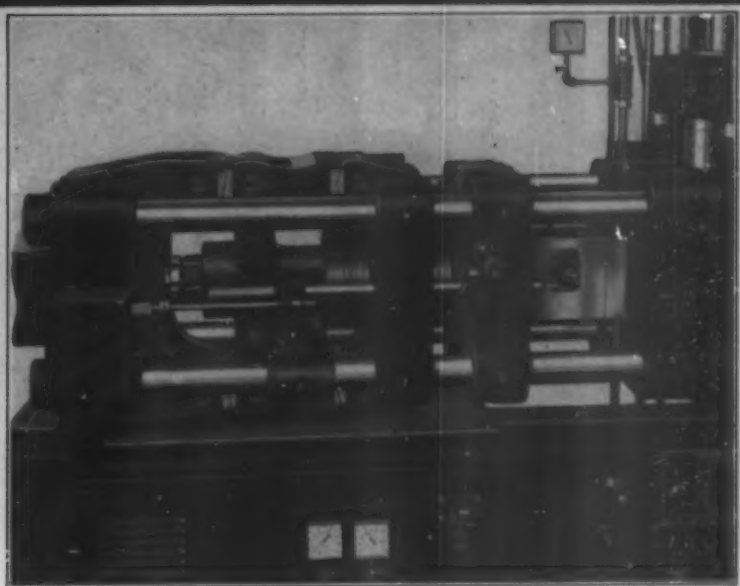
# **FULL AUTOMATIC** *Injection* **MOLDING MACHINE**

- 6-Oz. Capacity
- 40 Square Inches — 50 Lbs. Plasticized Material per Hour
- 50,000 Lbs. Total Pressure on Materials
- 3 1/4" Tie Bars to Carry the Load
- Injection Piston Stroke 8 1/2", Traversed in 3 seconds
- Single Operating Lever



## **HEATING CYLINDER EASILY ACCESSIBLE FOR ADJUSTMENT**

The heating cylinder swings free of the machine, making it possible to adjust injection nozzle and heating cylinder in a few moments. Cylinder, piston, nozzle and spreader are chromium plated to accommodate all materials. Temperature regulated by thermostatic control.



## **POSITIVE LOCKING OF MOLD THROUGH TOGGLE LOCKING MECHANISM**

Flash is eliminated by the positive toggle lock operated by wedge action. (Note illustration.) Molds positively held closed when molding 40 square inch area. Provides uniform adjustment of die plates on the tie bars, by worm and worm wheel. Single operating lever.

## **ISOMA INJECTION MOLDING MACHINE**



This machine is especially designed for smaller work with 1 1/4 ounce maximum weight. Its full automatic operation coupled with uniformly heated material, made possible by a patented heating cylinder, insures a uniform product and maximum production. Intricate parts of all kinds, including those with internal threads, can be automatically molded at an exceptionally high rate of speed. Because of its outstanding performance throughout the world, ISOMA has won the confidence and endorsements of high grade molders everywhere.

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DETROIT AGENTS -- J. C. AUSTERBERRY'S SONS -- 332 CURTIS BLDG

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THE PERFECT FASTENING FOR  
ALL PLASTICS

**TAP AND FASTEN**  
*in one operation!*

Shakeproof's new "Hi-Hook" Thread-Cutting Screw solves the problem of making tight and rigid fastenings in plastics at low cost. This amazing screw actually cuts a clean, sharp thread in any plastic material. It drives easily, too, because its double-slot design assures an acute cutting edge. Test Shakeproof's "Hi-Hook" Thread-Cutting Screw on the material you are using—see how it lowers costs and speeds up production. Write for your free demonstration kit, today!

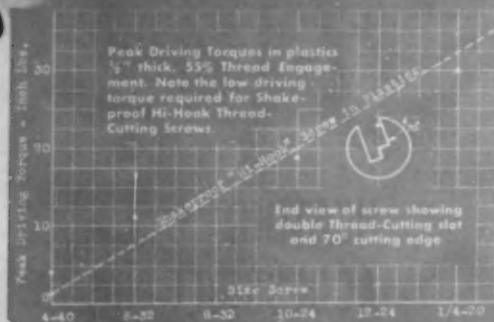
U. S. Pat. Nos. 1,862,486,  
1,909,476, 1,909,477.  
Other Patents. Patents  
Pending. Foreign Patents.

#### SHAKEPROOF LOCK WASHER CO.

Distributor of Shakeproof Products Manufactured by Illinois Tool Works  
2507 North Keeler Avenue Chicago, Illinois  
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The Only Screw that actually cuts its own thread!



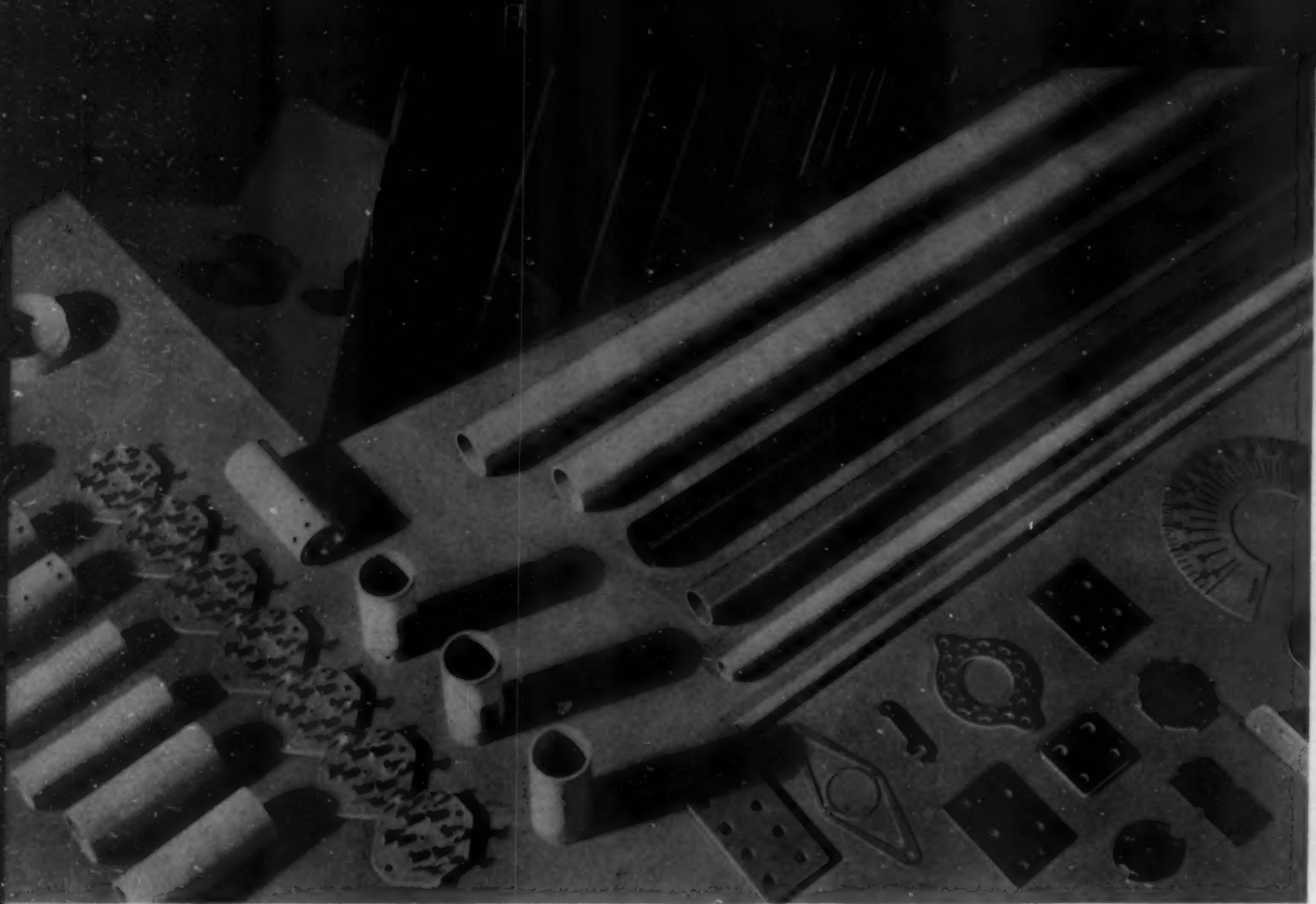
**Double Thread-Cutting Slot  
PRODUCES CLEAN-CUT THREAD  
AND ASSURES EASY DRIVING**

*Send For Your Free Demonstration Kit Today!*

# INDUSTRIAL AND DECORATIVE LAMINATED

PAGES 279-298

INDUSTRIAL LAMINATED  
DECORATIVE LAMINATED  
RESIN BONDED PLYWOOD



Laminated sheets rods and tubes are fabricated into a huge variety of radio parts. (Photo courtesy Synthene Corp.)

## EVOLUTION OF LAMINATED PLASTICS

by G. E. LANDT

A DISCUSSION OF LAMINATED CELLULOSE PRODUCTS rightly commences with the consideration of cellulose fibers formed into sheets of paper, as laminating consists essentially in combining sheets of paper in one of several manners. In the plastics industry, such combinations take place between the platens of a hydraulic press, under hydraulic and steam pressure.

Cellulose is perhaps the earliest organic material that found extensive application as insulation in the electrical industry. Its high dielectric strength, its low power factor and low dielectric constant placed it in an especially advantageous position in applications to direct and alternating circuits. The ease of fabrication into special parts permitted a very wide development of structural forms as required by design considerations.

Cellulose has one important weakness as an electrical insulating material—it combines readily with moisture, particularly hygroscopic moisture, and the insulating qualities of this combination are very much impaired. Hand in hand, therefore, with the applications and developments of cellulose products in industrial fields,

there developed a demand to eliminate this hygroscopic absorption of moisture. The attempts to do this were numerous, but always ineffective, because the thirst of cellulose for moisture is excessively powerful.

Naturally, one of the first applications of phenol-formaldehyde resins was to the solution of this problem. These resins serve substantially to solve this problem, for, while phenolic laminated materials still do absorb moisture, such a marked improvement has taken place that paper sheets impregnated and bonded with phenolic resins possess approximately the same degree of water resistance as many inorganic materials, generally considered to be "waterproof."

The first application of these materials to electrical uses was made about 1910 and a limited quantity of laminated sheet and tubular insulation was manufactured during the following decade. They received their first great impetus in the electrical field with the development of radio. In the early Twenties, with the first development of radio receivers for domestic use, a tremendous demand developed for insulating panels, whose most important

# FORMICA WAS USED

*in Many ways*  
in this Residence



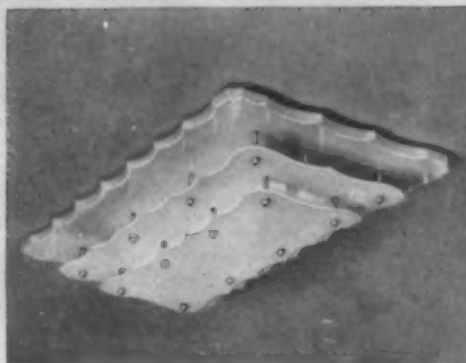
IN this splendid ten room house built by H. A. Faber at Raeburn Cincinnati, Formica was used in many ways including some that are new. In addition to those illustrated it was applied as a shower curtain and for window stools in many windows.

Formica offers a durable, stain-proof surface available in many colors. For walls that must see severe service it offers a covering that combines beauty, modernity with practical values of a high order.

We have literature—some of it illustrated in full color—which shows in detail the uses of the material and the methods by which it is installed. Ask for it.

**THE FORMICA INSULATION CO.**  
4672 SPRING GROVE AVE.  
CINCINNATI, OHIO

## FORMICA



Formica Lighting Fixture made with translucent material.



Formica plaque in color and metal at entrance.



Formica Kitchen Cabinet tops and wainscoting.



Double window made with white translucent Formica.



Formica covered walls in a bathroom.

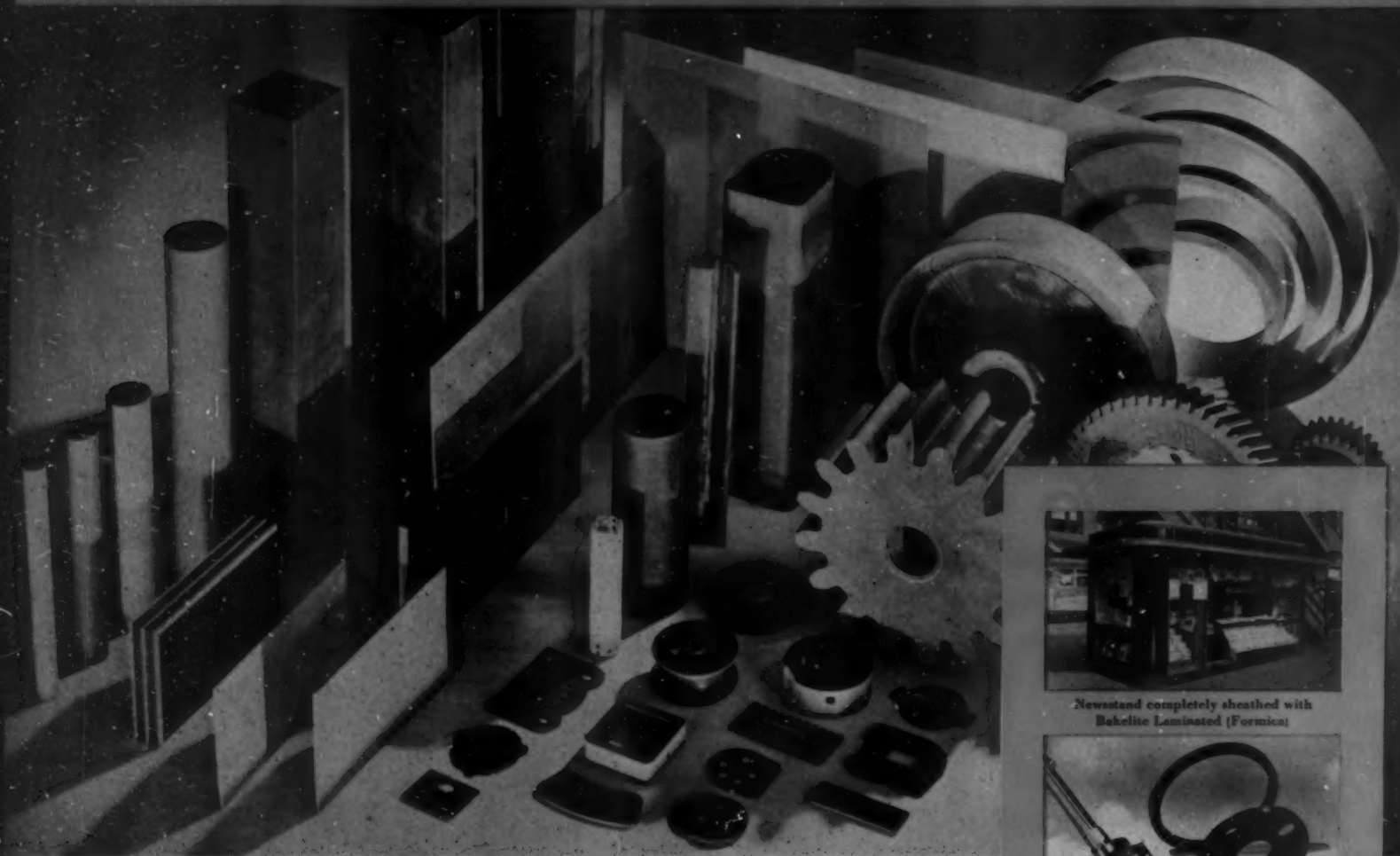
**FOR BUILDING PURPOSES**

OCTOBER 1937

281

# Bakelite Laminated...

A DURABLE, MANY-PURPOSE MATERIAL



**H**ERE is a material of such versatile service that it cannot be accurately classified by reference to one of its outstanding functions or characteristics, alone. Bakelite Laminated is a *special* material for numerous widely different purposes!

In many of its applications, Bakelite Laminated is employed primarily for its mechanical characteristics; in others, for its valuable electrical, chemical or thermal properties; and in still others, because of its decorative capabilities. In *each* of these respects, it possesses outstanding merits.

Present applications of Bakelite Laminated range from structural decorations to silent gears; from fire-resistant trim

and furnishings in ships to high frequency electrical insulation; and from strong, light-weight appliance parts to non-corrodible pipe. Further advantageous applications of this material are practically unlimited.

Bakelite Laminated is available in sheets, rods, tubes and gear blanks of many dimensions. Special shapes and sizes may be readily obtained. For decorative purposes, it is made in a variety of colors. It may be worked with ordinary tools. Our engineers will be glad to cooperate with you in applying this versatile material in any proposed design.

For useful information on other Bakelite Materials, see pages 73 and 87 of this publication.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N.Y.  
BAKELITE CORPORATION OF CANADA, LTD., 163 Dufferin Street, Toronto, Ont.  
West Coast: Electrical Specialty Co., Inc., 316 Eleventh Street, San Francisco, Cal.

## BAKELITE

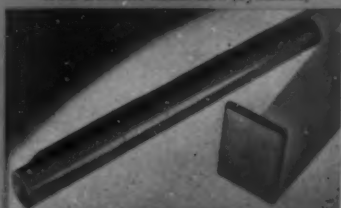
The registered trade marks shown above designate materials manufactured by Bakelite Corporation. Under the capital "B" is the Bakelite logo, a stylized "B" inside a circle, which is a registered trademark of Bakelite Corporation.



Newsstand completely sheathed with Bakelite Laminated (Formica)



Waukesha Octane Rating Engine parts made from Bakelite Laminated (Synthene)



Circuit breaker and bus-bar insulators of Bakelite Laminated



Watch display with lustrous surfaces of Bakelite Laminated (Formica)



Ball-bearing retainers made from Bakelite Laminated

THE MATERIAL OF A THOUSAND USES

requirement, however, was their decorative appearance.

During this ten-year period, a certain demand had also developed for insulation of exceptional mechanical stability and, to meet this demand, fabric as well as paper was impregnated with phenolic resin and laminated in a similar manner. The principal outlet for this product was in the manufacture of gears for noisy equipment, in order to reduce the noise developed in gear trains.

During the year 1925, changes in design of radio receivers produced a substantial revolution in the laminating industry. This revolution characterized the speed with which complete changes have taken place in this industry. The change in designs resulted in the elimination of radio panels. This change was quick and drastic. In the year 1925, one laminator sold two and one-half million radio panels. In 1926, he sold sixty thousand. For some years, this business has been non-existent.

At the same time, the more exacting requirements of the radio industry, and additional new developments in general industry, resulted in a complete change of front in the business of making laminated products. The new designs of radio receivers and the more exacting requirements placed on the insulation used in them resulted in a demand for laminated materials of superior insulating value. At this time, radio manufacturers began to emphasize and specify resistance characteristics, power factor and dielectric constant values, which placed excessive demands on the laminator for skillful technical production. Before this change, power factor values of 4 to 5 and dielectric constant values of 6 to 7 characterized laminated products. Since that time, the laminating industry produces materials within the power factor range of 2 to 3, and dielectric constant values of 4 to 5; with resistance values at high humidities a hundred times greater than previously. These requirements went hand in hand with the requirement for easy fabricating characteristics so that machined parts could be produced accurately in large scale production

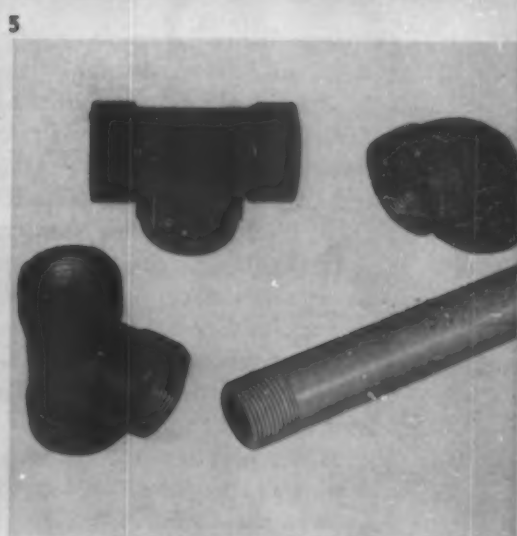
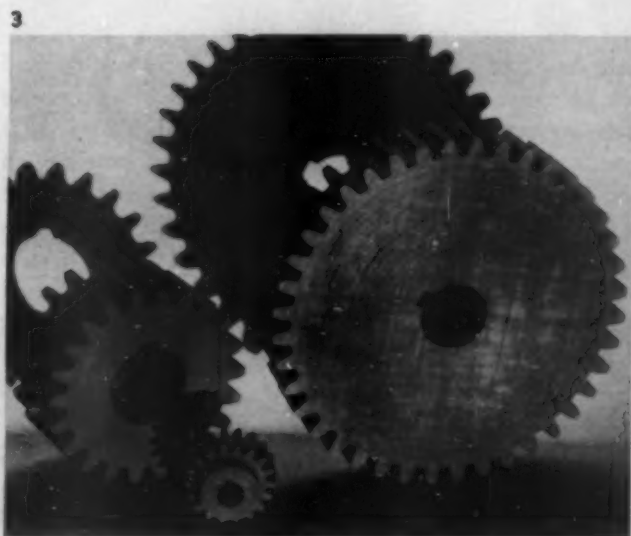
without undue losses. While this combination of electrical and fabricating characteristics is essentially antagonistic, nevertheless considerable headway was made in combining them in a relatively large measure.

At about the same time, the applications of a laminated fabric base material to the manufacture of industrial gears received tremendous impetus through the widespread adoption of the silent gear in the automobile timing train.

In the electrical field at the present time, the emphasis has changed from merely a demand for insulation of good characteristic values to insulation of good *stable* characteristic values. Such stability is a consequence of both improved resistance to moisture and resistance to deformation through mechanical agencies. As a consequence, materials are available today which will show a maximum of 5-10 percent increase in power factor and power loss after twenty-four hours' immersion in water and which will not exhibit more than 1 percent change in dimensions after several days' exposure to heat and pressure. This "geometric" stability is important in keeping electrical apparatus in precise alignment to precise dimensions in order to avoid trouble in use.

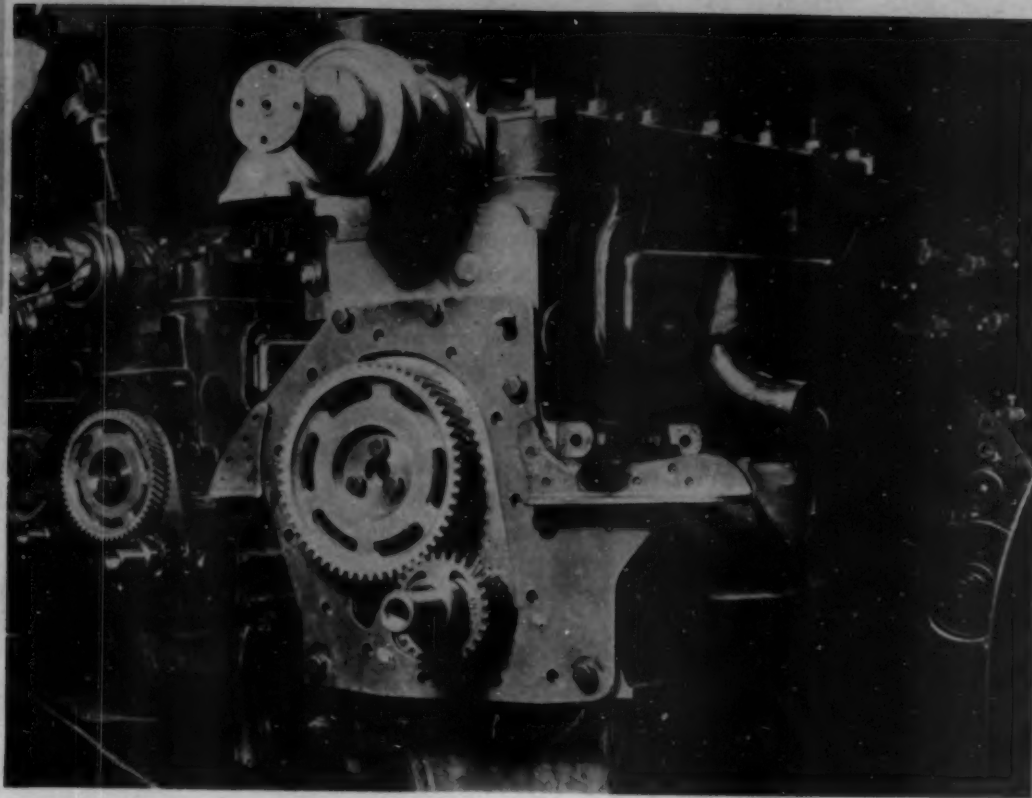
In the electrical field, the present trend is likewise

2. Insurok pinion gear on sand blasting machine in steel plant. 3. Industrial silent gears cut from Taylor phenol-fabric laminated gear stock. 4. Laminated motor pinion of Micarta. 5. Dilecto pipe and fittings

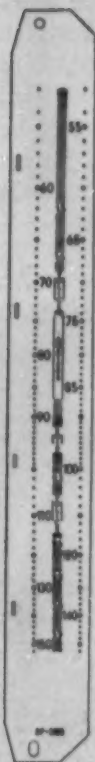




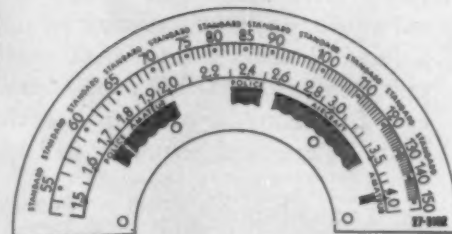
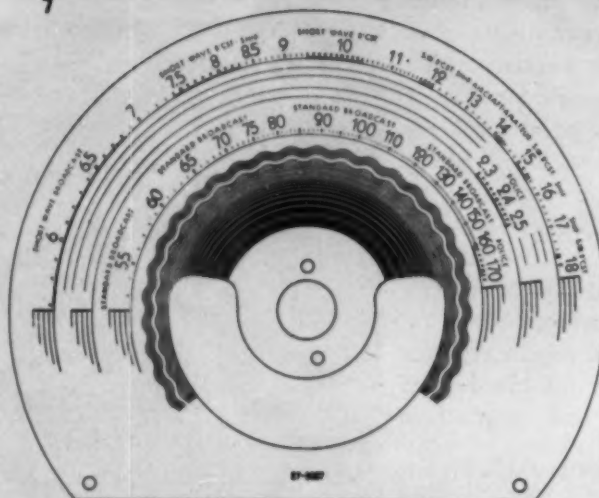
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7



8



6. Clutch disk of Textolite. 7. Spoke timing gear molded to shape from Celoron. 8. Dilophane radio dials

toward the construction of larger and larger insulating units to withstand high dielectric stresses. This is accomplished at the present time by laminating metallic layers in the body of the material to distribute electrical stresses uniformly and by using coating materials to reduce the tendency for surface tracking under an electrical discharge, as this characterizes phenolic products.

In the field of engineering applications of laminated materials, the requirements of silence have continued to exercise demands in the manufacture of timing gears. This has resulted in the development and extended application of the spoke gear for timing trains, whose structure and resiliency reduces noises to a minimum.

In the past ten years, the principal applications of laminated products as engineering equipment have been in the chemical field as corrosion-resistant piping

and equipment, outstanding among which is the development of the rayon spinning bucket to withstand the corrosive action of sulphuric acid solutions and the bursting stresses that are developed at high rotational speeds of operation. The development of bearings to the heavy duty requirements in rolling mills for the manufacture of steel and brass plate, and the further application of such bearings to industry in general, has marked another new chapter of success for laminated products. The extensive application of fabric base laminated materials in the paper industry furnishes an ideal application for suction box covers, doctor blades, table rolls, forming boards, bearings and save-alls. Again, the resistance to wear, the resistance to moisture, low coefficient of friction and resistance to corrosion, give the requirements for successful developments in this

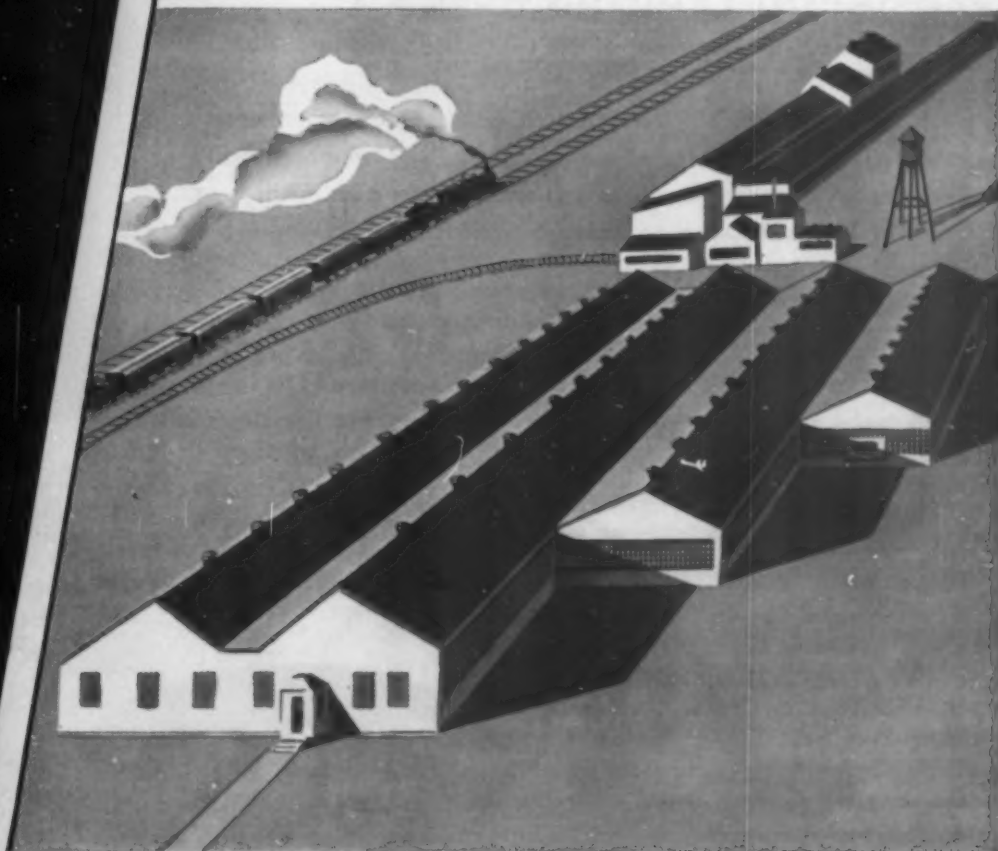
# TAYLOR

**VULCANIZED FIBRE • PHENOL FIBRE  
TAYLOR INSULATION • SILENT GEARS**

Increased demand for Taylor products called for greater manufacturing capacity . . . was met by new buildings recently completed, thousands of feet of additional floor space, new processing equipment, and a complete paper mill that is second to none in the quality of its output.

Taylor "Planned Service" is geared to meet requirements, large or small, standard or special . . . can be relied on, always, as an unfailing source of supply . . . permitting you to operate with smaller inventories. Ask for more information.

**TAYLOR FIBRE  
COMPANY  
NORRISTOWN, PA.**



# Designers and Manufacturers...

... find us specially equipped  
to handle their unusual problems

An increasing number of manufacturers are making use of Mica Insulator Company's unusual facilities and ready cooperation in the development and manufacture of new and improved laminated Bakelite materials. The examples cited are typical.

**DECORATIVE LAMICOID** The recently remodeled theatre front shown strikes a modern note in decorative design by utilizing Lamicoid paneling for exterior walls. This versatile material has been used to advantage by enterprising designers and manufacturers for such varied applications as fireplaces, furniture, store fronts, cabinets, exhibits, etc. Available in natural wood finishes and solid colors.

**TRANSLUCENT LAMICOID** This plastic sheet material, used for indirect lighting panel of the eye-catching counter display illustrated, has opened a new field for illuminated displays. It is a lustrous, flexible sheet with an unusual combination of structural features:—non-inflammable, non-shatterable, light weight, readily cleaned, easily printed or engraved, and low in cost. White or colors. Also available with an opaque surface for engraved signs, apparatus panels, etc.

**INDUSTRIAL LAMICOID** The Laminated Bakelite sheet material illustrated has materially increased the life of this manufacturer's plating barrels. It is the product of Mica Insulator Co.'s laboratory... one of the industry's most modern, completely equipped research units. Also available as standard sheets, rods, tubes and fabricated parts, for mechanical and electrical uses.

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200 Varick St., New York; 342 So. Dearborn  
St., Chicago; 1276 West 3rd St., Cleveland

*Branches at*  
Birmingham, Boston, Cincinnati, Los Angeles,  
San Francisco, Seattle, Canada: Montreal, Toronto

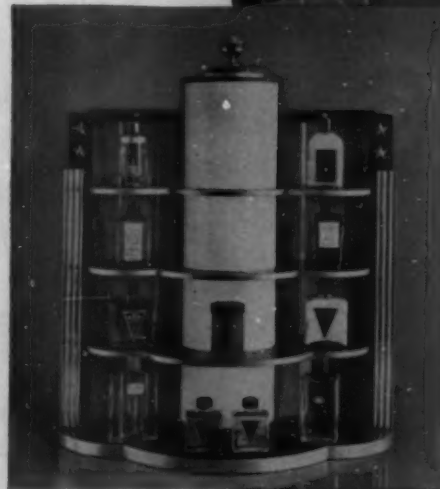


*SUCH AS...*

New decorative  
materials make  
possible modern  
architectural and  
display effects.



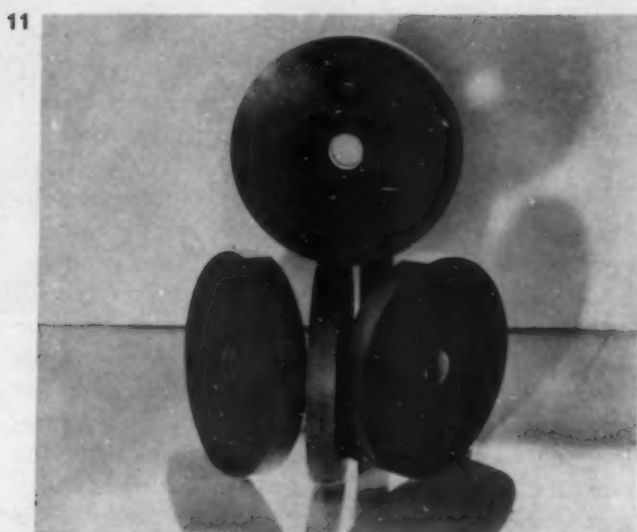
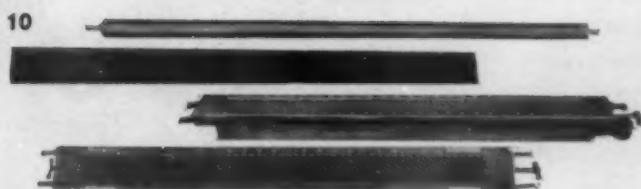
New, luminous  
paneling permits  
great flexibility in  
indirect lighting.



Improved acid-  
resistant plastic  
panels lengthen  
the life of plat-  
ing barrels.



# MICA INSULATOR COMPANY



9. Machined and molded Formica parts for electrical machinery and generating systems. 10. Di-lecto paper making machine parts, roll, doctor blade and suction box covers. 11. Laminated valve disks. 12. Rayon spinning buckets of Celoron

extensive industry where so much water is employed.

One of the special developments of laminated materials resulted from the development of electrical refrigeration. Laminated materials usually carry a characteristic phenolic odor, which is especially objectionable where food products are concerned. The requirement in electrical refrigeration for a moisture-resistant material of low thermal conductivity and decorative value produced the demand that laminated materials be manufactured without any odor. This demand reached its height in the beginning of the depression and the success of technicians in developing such materials was a considerable factor in keeping up the volume of laminated products during the depression.

One of the initial valuable applications of laminated materials resulted from their decorative value. In the radio field, this brought about the extensive adoption of radio panels and a subsequent decline of interest when radio panels were abandoned. The application of laminated products to decorative purposes awaited the solution of certain problems; the surfaces of laminated stock were too soft and were easily marred and scratched, materials were not light-fast, and colors produced darkened in shade very rapidly, and the cost of manufacturing such a product was too high. The solution of these problems brought about the extension of laminated materials into the building and furniture industry.

In the beginning, materials made from phenolic resins were the only ones available for this purpose. About 1930, the urea plastics had been brought to a point where they were suitable for laminating. For some years, the emphasis was placed on urea laminated materials in this field. The tendency of urea to warp and the difficulties involved in forming it left a demand for further developments. This was made in 1935, by the development of a material which represented a return to phenolic resins as a basic material for its manufacture.

This material is a laminated paper product obtainable in all colors, including the most delicate shades. It is light-fast, and weather resistant. It is *translucent*.

This last property extends again the fields into which laminated plastics have penetrated. This translucency permits the application of the material as dials and indicating devices of all sorts to meet the modern demands of designing engineers for transmitting light through the dial and throwing the lettering into silhouette relief. The suitability of the material for punching and forming, and its adaptability for printing, make it a valuable contribution to the hands of the decorative designers, and to the advertising specialists for illuminated signs.

The unique feature in the history of laminated plastics is the insistence with which manufacturers have returned to phenolic resins for the base of their operations. Future development of laminated materials and their further extension into our industrial and social needs will depend to a large extent on the further stabilization of these materials to mechanical and electrical stresses and to weather and light conditions.

# A YEAR'S PROGRESS IN DECORATIVE LAMINATED

by W. G. STEINER

SUBSTANTIAL PROGRESS HAS BEEN MADE DURING the last year in increasing the distribution of decorated laminated. With improving business conditions and the rise in volume of sales of all other commodities, this new material went ahead, too, and will probably show for the current year an increase over the level of 1929 of from 60 to 70 percent. In that respect its performance is somewhat similar to that of the plastics industry in general and many divisions of the greater chemical industry.

There has been progress too in the technical development which makes the production of the material possible, although these have been detail developments, and nothing of vital importance in a technical way has been initiated during the year.

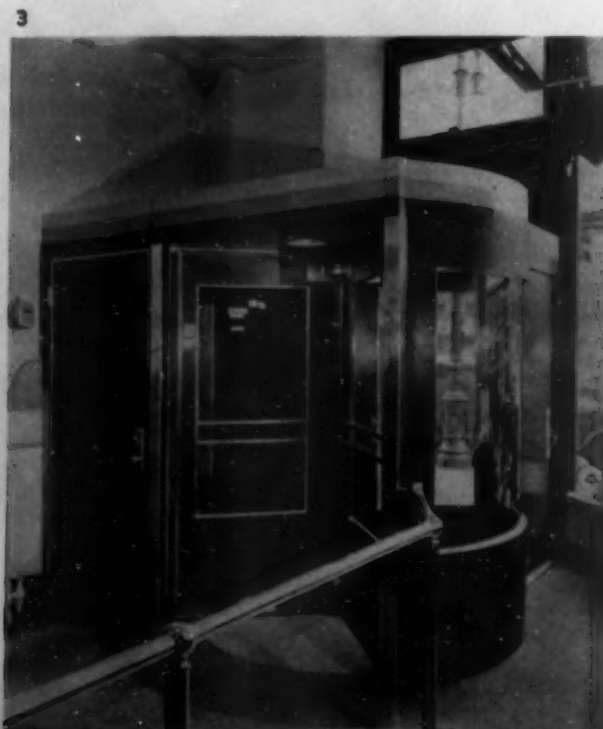
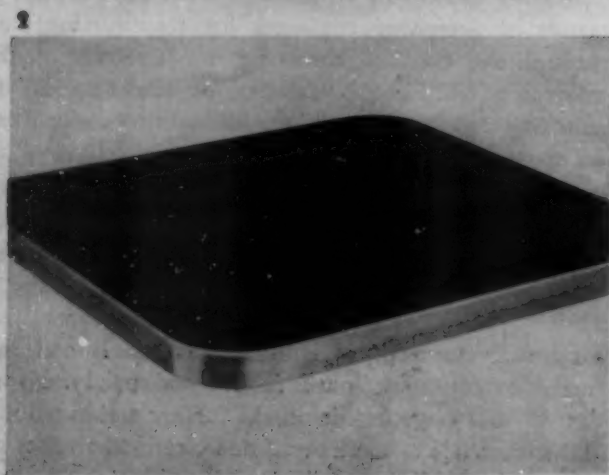
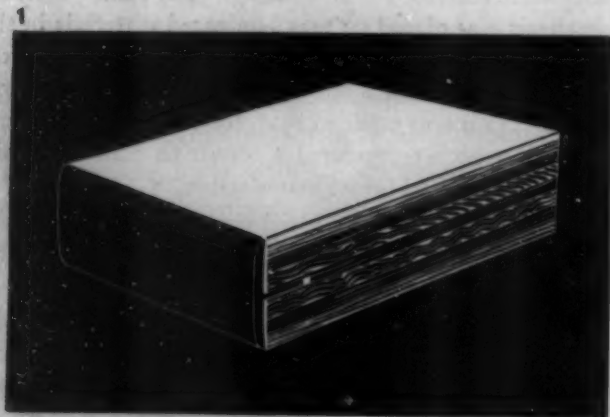
Translucent sheet, which is a pure urea laminated, has been developed further by the production of new urea

resins which have greatly increased the amount of light which can be transmitted, and made possible the production of a more uniform material. During the year a considerable number of additional laminators have begun the manufacture of such sheet which is especially of interest to the big electrical companies, two of which have their own laminating departments. Their close association with lighting and lighting problems naturally drew their attention to a material that promised wide usefulness in lighting fixtures, and provided a material that was not brittle and easily shattered, and capable of transmitting soft, diffused light.

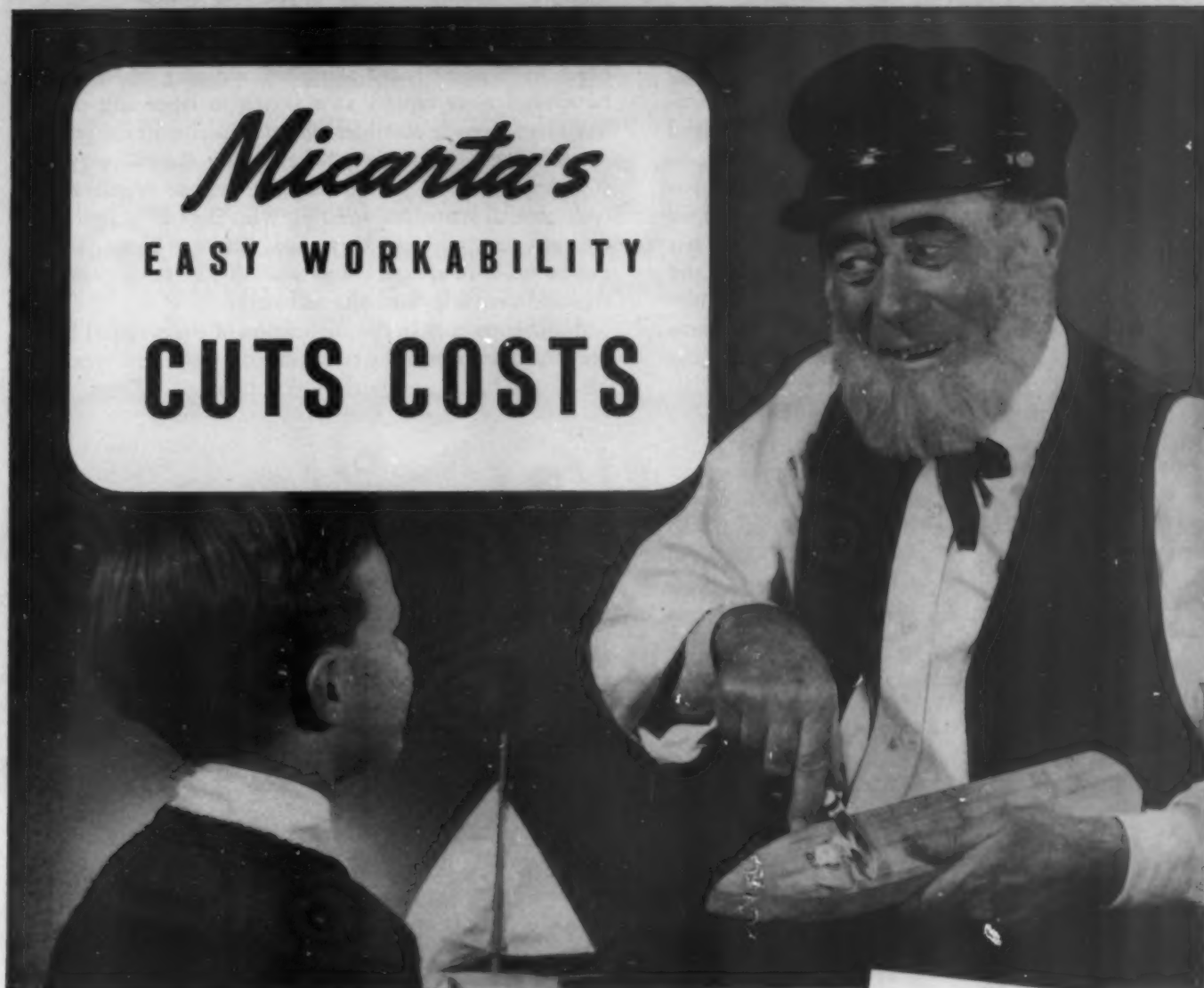
Due to the fact that this translucent urea material is very resistant to abrasion, its use has also been developed as a protective coating over the top surface of patterned decorative sheets of combination urea and phenol laminated, thereby greatly increasing the amount of wear that might be expected from table tops and other surfaces that are subjected to severe wear.

Two or three years ago the government interested itself in fire-resisting material with which to build partitions in the passenger quarters of ships. There was prepared and tested at that time a sheet with a light corrugated asbestos center and a plastic surface finish. In actual fire tests conducted by the government on various materials the performance of this combination was such that considerable interest has been aroused in it for the partitions of new ships that are now, or soon will be, under construction. One large modernizing job has already been carried out with sheets of these specifications, and doors were also finished in laminated plastic to match the paneling. This is an application in which the laminators and the manufacturers of asbestos sheets are cooperating toward the development of what gives

1. Detailed drawing showing construction Formica Type M top. 2. Laminated table top with edges covered with extruded aluminum molding. 3. Revolving laminated doors in a John R. Thompson Co. unit, installed by the International Revolving Door Co.



*Micarta's*  
EASY WORKABILITY  
**CUTS COSTS**



When your specifications read "Westinghouse MICARTA," you can be sure of low fabrication costs. Its easy workability results in fast production and uniform quality of product, without excessive spoilage. Production costs also are less because special equipment is unnecessary. MICARTA is easily machined, sawed and drilled with ordinary machine tools. It punches readily. It can be tapped easily and will hold the thread.

Yet MICARTA'S easy worka-

bility is achieved without sacrificing in any degree its high dielectric strength, great mechanical strength, low moisture absorption and other properties which have made MICARTA the "cure" for many difficult design and production problems.

Investigate MICARTA. Send today for complete technical details. Be sure to name your products. Westinghouse Electric & Manufacturing Company, Micarta Division, Trafford, Pa.

**M I C A R T A**  
is THE laminated  
plastic that balances  
most advantageously:

- 1—Easy Workability
- 2—Great Mechanical Strength
- 3—Low Moisture Absorption
- 4—High Dielectric Strength

**Westinghouse MICARTA**



promise of being a considerable volume of business if and when the American ship building industry revives on a good scale.

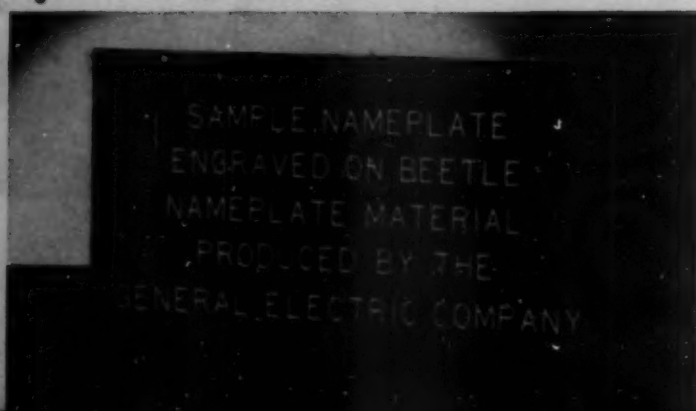
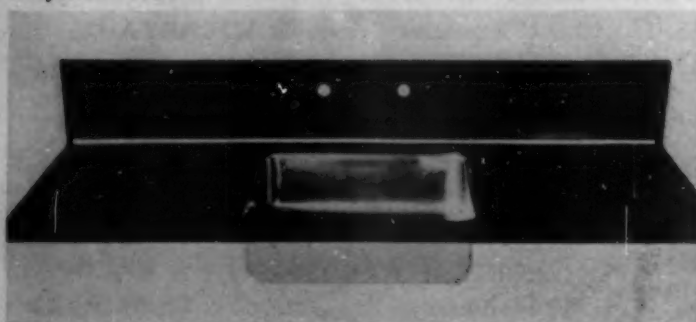
In connection with use of plastic laminated for fire-resisting purposes, one of the companies has developed what has been called a flame-resistant sheet, by incorporating in the mix with which the laminated sheet is made some of the chemicals that are commonly used for purposes of extinguishing fires. This treatment has increased the resistance of the material to igniting and flaming. As it is an organic material it will still carbonize if submitted to sufficient heat, but it will not flame and the treatment has been found to greatly reduce the amount of fumes given off by the burning of the material.

There have been developments, also, in ways of using plastic sheet that would cut down the final cost of the product. For instance, in table tops with plastic surfaces it had previously been the practice to cover the edges of the table tops with plastic sheet as well as the top surface. This matter of covering and finishing the edges required a great deal of careful hand work and was an important factor in making the table top covered

with plastic laminated one of the more expensive types. A method has now been developed of covering these edges with an extruded aluminum molding which can be applied more rapidly at a saving in labor and time and this has made possible a sharp reduction in the price of table tops of this sort. They retain the full plastic top sheet with all the advantages, lack of brittleness, resistance to stains and spotting with liquids or lighted cigarets, etc., which they had before. These tops can be made in all the colors available in other plastic tops and with inlays in color and metal.

Another novelty in the application of the material has been the development by two laminators of a new type of kitchen cabinet top with sinks attached. These are made with a top surface of  $\frac{1}{4}$  or  $\frac{3}{8}$  in. solid laminated sheet. A strong wood frame is used around the edges to support the top and give it an appearance of greater thickness. This edge is finished by covering with an angle channel of laminated material. A back splash of laminated sheet on wood is attached and the whole thing is shipped to the kitchen cabinet manufacturer or dealer from the plastic fabricator's plant with the sink already

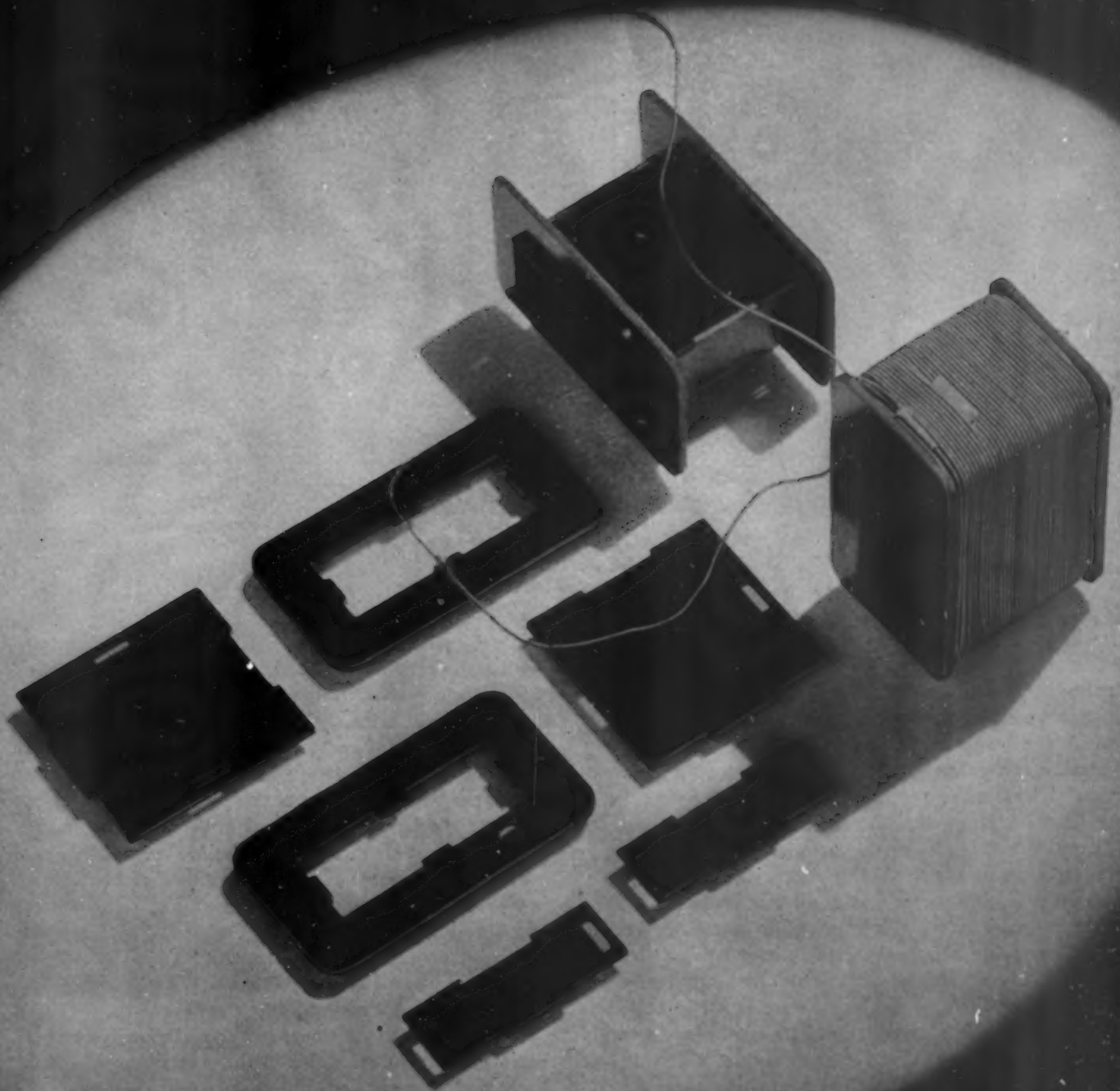
4. Interior of Hoi Sai Gai Restaurant, Chicago, in which Formica is used for exterior of all booths, table tops, bar top, back bar and ceiling lighting fixtures. 5. Micarta is used in the interior of the Nita Theater, Chicago. 6. Formica store front in red and white checks. 7. Kitchen cabinet top made with thick laminated sheet. 8. Laminated Beetle nameplate panel, made by General Electric Co.

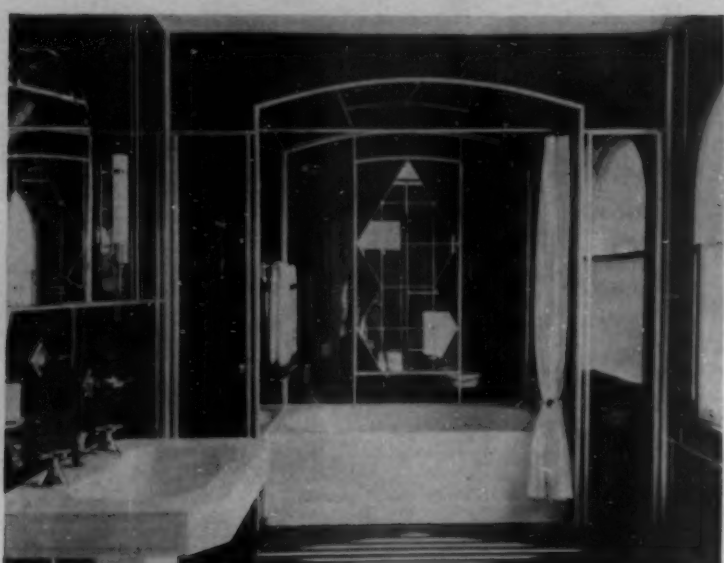
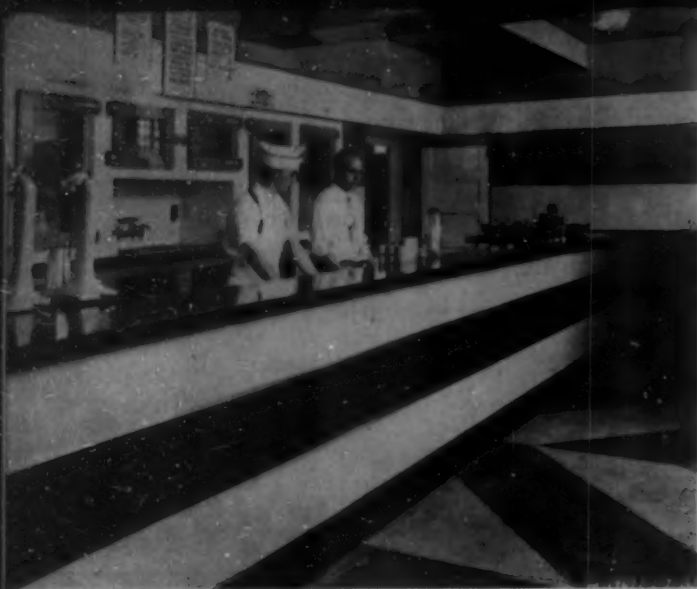


*We asked a maker of sounding devices why he selected Phenolite (laminated bakelite) for use in his products. In reply he pointed to this ingenious coil form assembly in which (1) six punched parts of Phenolite are fitted together in perfect alignment, (2) wire is wound on the spool to form an electro magnet. In Phenolite he finds these unique fabricating possibilities, electrical and mechanical strengths. Light, rigid, non-splintering. Resistant to weather, heat and moisture . . . Perhaps you, too, will find in Phenolite, laminated bakelite, (or National H·A·R·D Vulcanized Fibre) a short cut, betterment or economy in product or plant equipment.*

NATIONAL VULCANIZED FIBRE COMPANY, *Wilmington, Del., U. S. A. (Offices in Principal Cities)*

**NVF**





Soda fountain top, paneling and ceiling in Page Dairy are of Micarta. 10. The working surfaces in this kitchen are covered with laminated material. 11. Laminated bar and table tops are easily cleaned. 12. Micarta paneled bath room

attached. These have been made in standard sizes to fit the standard cabinets for which there is the greatest demand. The price is in line with other high grade materials used for the same purpose, and the application promises to have some future.

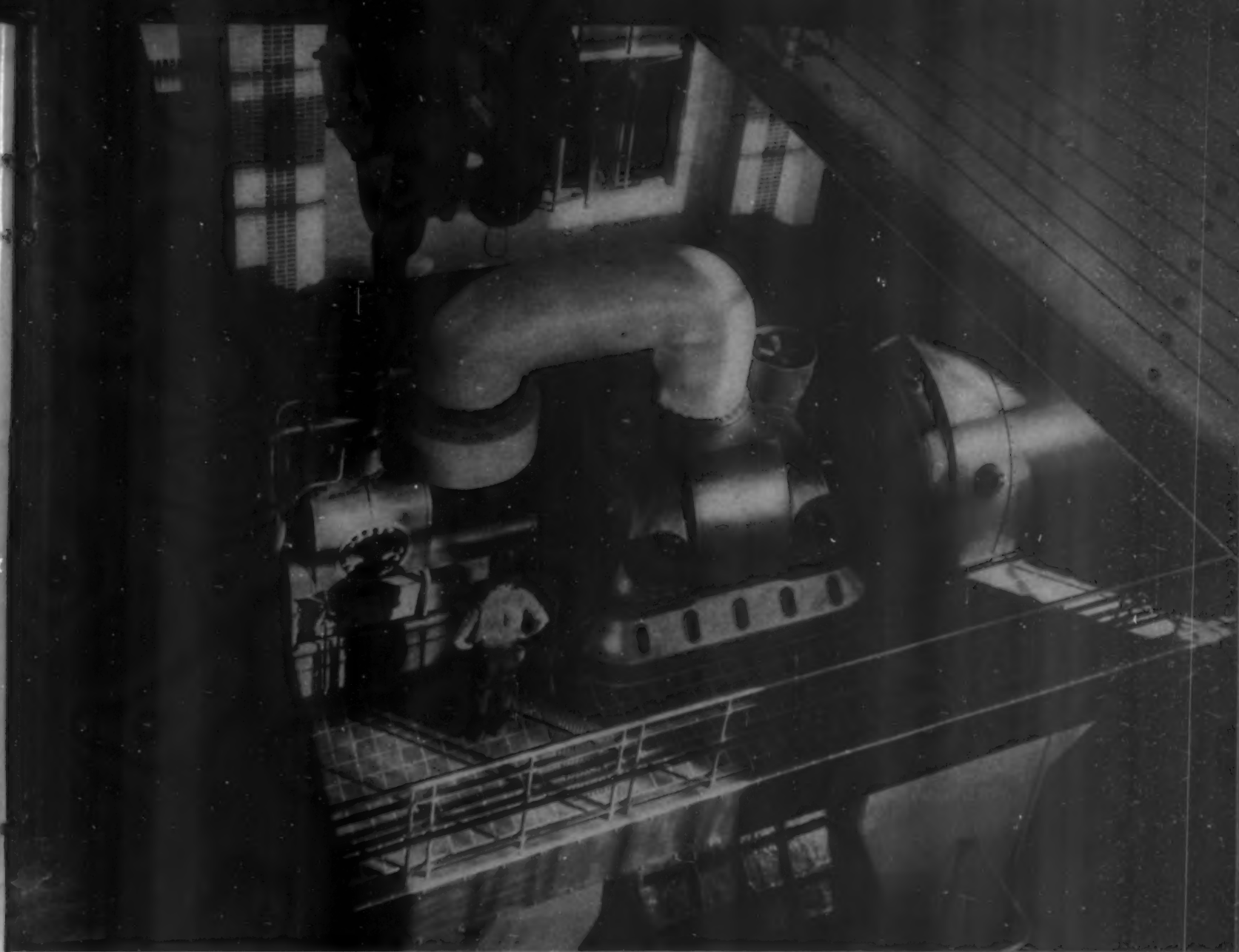
During the year the established applications of the material have shown greater activity than before, in part a reflection of the improvement in business everywhere. All of the leading soda fountain manufacturers now offer counters covered with plastic veneers, and they constitute a large percentage of all the fountains sold.

The railroad industry in building its new high speed trains has made almost universal use of laminated for table tops in the lounges, window sills and in some cases bars in tavern cars. Some very attractive bar jobs with translucent panels have been developed for this purpose. Several of the leading chain store companies have standardized on laminated for such uses as column covering, wainscoting and counters, and have been opening and modernizing many stores recently which increased the amount of material flowing through that outlet.

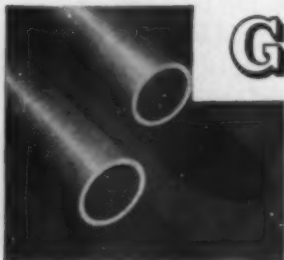
The largest specification of laminated sheet for any one single operation was made by the Architect of the Capitol in laying out the new Annex to the Library of Congress, where \$100,000 worth of the material will be installed for wainscoting, baseboard, telephone booths, card index drawer fronts, book conveyors and many similar uses. The erection of this building is now under way and the laminated material is being manufactured and installed at the rate of about \$10,000 worth a month.

Facilities available for the production of decorative laminated have been strained to the utmost in getting out orders during the early months of 1937, and considerable new equipment has had to be provided as rapidly as possible in the way of presses for molding baseboard, additional facilities for making inlays and so forth.

Still the product continues as a specialty with a rather narrow market, due chiefly to the cost factor which is high, and it seems doubtful that it will ever move in very large volume until an entirely different type of equipment is available for making it which will reduce the time and labor of the process.



## POWER NEEDS PROTECTION



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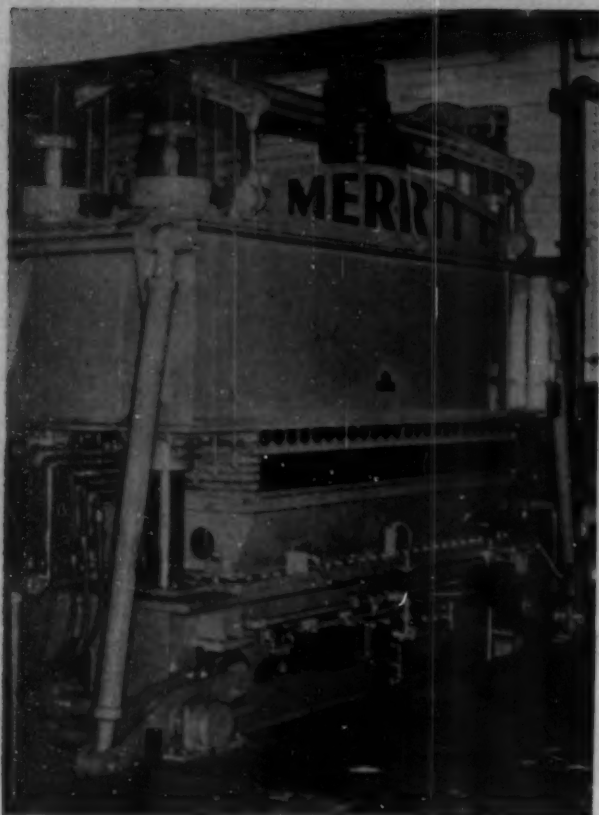
tions. . . . *Synthane* Bakelite-laminated is a uniformly dense, solid material possessing a combination of useful physical, chemical, mechanical and electrical characteristics. It is tough, strong and light in weight; one of the most effective dielectric materials; chemically inert and corrosion resistant. It is easy to machine. The uses for *Synthane* are countless. . . . *Synthane* is a type of

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1



2

1. Quick acting hot press for resin bonding in a fir plywood plant. 2. Resin bonded plywood used in "speed wall" prefabricated wall. (Photos courtesy I. F. Laucks Inc.)

## RESIN BONDED PLYWOOD

by I. F. LAUCKS

THE IDEA OF RESIN BONDED PLYWOOD IS NOT very many years old. In fact, it may still be said to be in the development stage. A good deal of information still needs to be obtained on the subject. One good evidence of this at the present time is the discussion now being had among plywood manufacturers and plywood buyers as to proper specifications for resin bonded plywood. It must be remembered that the hot press in the United States is also only a few years old. It is true that certain pioneers have used the hot press for a long time but its use was not at all common and both the adhesives and processes for using them were quite different from those now available. At the present time the situation is quite the reverse. The hot press has become a common piece of apparatus in plywood plants, both East and West, and new adhesives and processes now available have opened extensive and attractive new fields.

Resin bonded plywood followed the hot press. This may seem like a truism, but what I mean to say is that the hot press was first used for the sake of the advantages

which the hot press itself has to offer plywood and from this use of the hot press sprang the idea of using resins as bonding agents.

The idea of an absolutely waterproof plywood has long been in the minds of those in the plywood industry. Plywood has, of course, in the past in the cold process had to content itself with glues which could be called no more than water resistant. It is true some of these were highly water resistant, but, nevertheless, they could not be called waterproof. Since the glues or the glue lines were much less water resistant than the wood itself the tendency of the plywood manufacturer in thinking on this subject was to consider that if he had a waterproof glue his troubles in this direction would be over. In other words he lost sight of the fact that the wood itself was one very essential element of a waterproof panel. Now that the glue line has been made waterproof the responsibilities of the wood in the partnership of wood and glue are being more clearly brought out. It is now even being thought that the wood itself may have be-

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3. Resin bonded plywood in exterior of I. F. Laucks Inc.'s plant. 4. Radiobar made of Tego-bonded plywood by Tyler Cabinet Co.

come the weakest member of the partnership and more thought must be paid undoubtedly to behavior of wood, to the stresses set up in it, to the action of heat on it, to make a more perfect panel. It may even be necessary to do something to improve the natural properties of the wood either before or after making up the panels.

Probably one reason why the idea of resin bonded plywood became popular so quickly was due to the very considerable interest which has developed lately in the idea of using plywood in building construction. Of course, the idea of prefabrication had a great deal to do with this, but not only is plywood almost essential in the prefabrication of buildings, but also the builders of conventional style houses are more and more being attracted by the possibility of savings and improvements in construction by the use of plywood. Also it might be said that the idea of resin bonded plywood came along at the psychological moment. The plywood consuming public was ripe for the suggestion. Of course, it might also be said that the suggestion was made because of the growing demand for such plywood. It may be another illustration of what has been so often observed in the development of industry, that when the need for a product arises the product is shortly thereafter produced.

As a matter of fact there is a great deal of ordinary cold process plywood used in many situations where it is exposed to the elements, in some cases in quite severe conditions. It is true that failures occur from time to time, but this, to a great extent, is due to the necessary variables of the cold process of laying up plywood. In other words, the best panels possible to produce by the cold process of plywood manufacture are quite weather resistant. It must be remembered that the hot press process of producing plywood can be made extremely uniform and that this is one of its very great advantages over the cold process. This matter of uniformity is per-

haps not generally realized by the plywood consuming public and it is worthwhile to digress for just a moment to consider this matter.

In the cold process of laying up plywood a bundle of plywood panels is assembled, each being successively spread with glue and laid up one on top of the other until the bundle may contain anywhere from 50 to 75 panels. This operation may consume anywhere from 15 minutes on up to in extreme cases an hour or so, depending on the difficulty of assembling the panels, the speed of the workmen and other considerations. When the bundle is finally built up to the desired height it is then put under pressure. Now it happens that the interval of time that elapses between the moment when the glue is first spread and the moment when the panel goes under pressure is a most important interval of time as far as the quality of the gluing is concerned. It will be seen from the above description that this interval varies in the cold process over quite a wide range, consequently the quality of the panels is also bound to vary.

In the hot press process, however, things can be so arranged that this time variable does not exist and it further happens that with resin glues this interval of time is not so important as it is with the cold process glues. So from two standpoints resin glued panels can be made much more uniform than can cold process plywood. This matter of uniformity is one of the most important properties of resin bonded panels.

When to the waterproof resin glue line is added the possible improvements in uniformity and the freedom of the resin glue line from attack by mold, rot, fungus, etc., it will be seen that a properly made resin bonded panel is quite a different matter from the old idea of plywood. It is now possible to produce a new type of engineering material whose properties can be predetermined well within the limits of the usual structural materials.

While the first thoughts of resin bonded plywood were undoubtedly along the lines of producing plywood to meet outdoor conditions, still as the resin bonded idea developed it has been found to have many other adaptations and fields of usefulness outside of plywood for outdoor uses. The high grade cabinet and furniture trade is a case in point. Ever since furniture has been made the need for water resistance in the veneer has been recognized. This need became more apparent, in the more humid climates in which the furniture was to be used. Periods of high humidity are common in a large part of the furniture consuming area of the United States and, in countries to which the furniture industry might well export, such as tropical countries, these humid conditions are all the more apparent. Not only is the humidity of the atmosphere important, but many pieces of furniture are subjected to accidental contact with water during their lifetime. So that, from many standpoints, the matter of water resistance in furniture and like constructions is of great importance.

But in spite of this great need for water resistance almost no furniture was constructed up to the last few years with any water resistance in its glue lines, and the reason for this could undoubtedly be laid to two causes:

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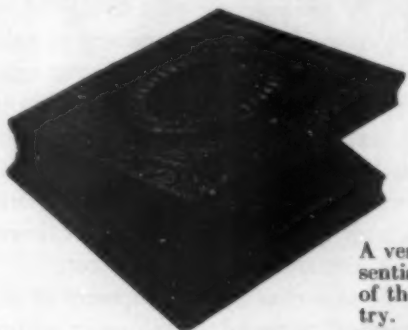
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## TECHNOLOGY OF PLASTICS

*H. W. Rowell*



and how they are made. First principles in theory and practice are given so that executives, students and business men, without benefit of technical training may learn the how, when, what, where and why of this new and quickly growing industry.

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First, because of the fact that in the cold process, used exclusively until a few years ago, the only water resistant glues available were glues which caused a great deal of trouble with stain. Stain in general was due to the alkaline nature of these glues, a certain portion of the alkali migrating to the surface of the veneer. This necessitated a great deal of care and extra expense to prevent. As a result, water resistant glues were not frequently used in the furniture industry. A second reason was the fact that the water resistant glues of the cold process were hard on the cutting tools used in the furniture industry. As a result of these two peculiarities of cold process water resistant glues they were little used. In other words, the furniture manufacturer preferred to take his chances with troubles due to lack of water resistance than to make water resistant panels and endure the manufacturing difficulties he would encounter.

Now, however, the situation has greatly changed. The hot press has enabled certain resins to be used in the manufacture of high grade cabinet plywood or furniture plywood which give the furniture manufacturer all the water resistance that he needs in his product and, at the same time, present not the slightest risk of stain. Also they are easy on the cutting tools. As a result these resins are becoming more widely used in radio cabinet manufacture, furniture and other high grade plywood.

Recent developments in resins for plywood have resulted in important advances. The importance of speed

of set has been more and more realized since the time that plywood has to remain in the hot press in order to set the resin determines to a large measure the output of the press and also the cost of the plywood produced. If resin bonded plywood is to become widely used it is highly essential that its cost be reduced and one of the most important developments in this respect has been the development of quick acting resins. Once these quick acting resins were an accomplished fact it became necessary also to develop quicker moving hot presses in order to get the full advantage of the speed of the resins. Such new quick-acting presses are also an important factor in reducing the cost of resin bonded plywood.

It also happens that these quick-acting resins have the property of setting at a low temperature. Low temperature is especially important on many woods. Some woods are discolored by high temperatures. With other woods, other effects develop . . . sometimes weakening, sometimes checking with unduly high temperature; so it becomes important to find resins which will set at the lowest possible temperature in order to preserve the best natural qualities of the wood.

In the last year or so there has been considerable discussion about tests for resin bonded plywood for outdoor use and this discussion is still proceeding. In some quarters boiling tests have been advocated. Boiling tests, however, have been found to be of little practical value in testing of glue lines. The boiling test is a spectacular one, but, unfortunately, not a practical test, because little plywood is subjected to boiling. Practical plywood and glue manufacturers found out long ago that it was not practical when the boiling test was proposed for casein glues. It was found at that time that glues that would pass the boiling test with flying colors would not necessarily pass the test of exposure to cold water or to atmospheric conditions. Much better tests than the boiling tests are alternate soaking and drying tests, or better still, exposure to actual outdoor conditions. Where the use of resin bonded plywood involves preserving the full strength of the wood, strength and puncture resistance tests may ensure against weakness due to abusive heat treatment in manufacture.

In general it may be said that the development of adhesives for resin bonded plywood is taking a course similar to that of the older plywood glues. No single ideal adhesive to meet all conditions and suit all products is probable because different resins have different properties and meet different needs. The one common essential is extremely high water resistance and bond strength. The economic advantage of ability to set fast at low temperature is also obvious. To utilize speed, fast press action is necessary and the old type of hot press is slow. Therefore, prospective manufacturers of resin bonded plywood will be wise if they avoid handicapping themselves at the start in the matter of slow acting presses. Before actually equipping a plant to make any of the several classes of resin bonded plywood, the various resin adhesives should be studied to find out their respective fitness for the work in hand and then modern equipment can safely be purchased.

5. Wall units for Gunnison Homes, resin bonded, are in sound condition after tossing two weeks in Ohio flood waters in this Albany plant. (Photo courtesy Resinous Products & Chemical Co. Inc.)  
6. Resin bonded fir plywood sheaths wood framed building. (Photo courtesy General Plastics, Inc.)



# PRODUCT DEVELOPMENT

PAGES 299-318

AUTOMOTIVE  
AVIATION  
ELECTRICAL  
RESIN TREATED FABRICS  
TYPICAL INJECTION MOLDINGS



Various forms of plastic materials are shown at top while below are some of the objects fashioned from plastics which are commonly used in automobiles of today. (Photos courtesy General Motors Corp.)

# PLASTICS AND THE MOTOR CAR

by HARLEY J. EARL

PLASTICS ARE TAKING AN INCREASINGLY important place in the interior decorations and in some of the other details of the modern automobile. The popularity of plastics in motor car construction has come swiftly. Only within the last five years, for example, has it been deemed possible to mold as complicated an object as a steering wheel. Now it is appreciated that plastics constitute a much better material for this purpose than any other now available.

The experience of the last few years, with their history of development and achievement, serves as an indication of what may be expected in the future, as ways are found to mold even more complicated parts used in the manufacture and decoration of automobiles. Plastics have been, and will continue to be highly successful because of their ease of fabrication, beauty of finish, permanency of color, and absolute accuracy of manufacturing. Already, these pieces formed of plastics are going into the automobile: steering wheels, horn buttons, gearshift balls, instrument board parts, control knobs, instrument cluster faces, dome light lenses, hardware knobs and escutcheons, and various minor pieces, such as robe rail ends, light switch buttons and assist strap ends.

Development of plastics, particularly of cellulose acetate, which leads by a wide margin over other forms of plastics used in the automobile industry, has been greatly enhanced by the manufacturers of this material. There were many problems to be mastered in the wide variety of specific pieces comprising interior adornments. For instance, a steering wheel presents quite a different manufacturing problem from that presented by hardware knobs. Perhaps most important has been the contribution of molders and fabricators in the development of various materials and methods of molding with new types of machinery. The chief processes being used at present are pressure molding and injection molding, the latter of which presents a newer and faster method. This development of molding processes carries with it the necessity for working out suitable materials. In injection molding the material is injected into the mold under great pressure, and upon the composition of this material depends the results obtained.

Almost as important as the method of fabrication has been the selection of suitable colors to fit interior schemes. In this, material manufacturers have played a leading part, developing materials the colors of which are so permanent they will last the life of the car. The use of color is ever on the increase and will continue to be more and more of a factor in the determining of new materials. Cellulose acetate has been most satisfactory, in that the material lends itself to an unlimited number of

colors. Along with the development of color has come the addition of aluminum powders, which have given plastic products a very interesting texture, and which have been used successfully by several leading motor car manufacturers.

Solid colors and semi-translucent colors are enjoying great popularity in that they are keyed to the modern tempo. Ingredients of these materials will determine their future success in relation to the methods of fabrication to be used.

Some very interesting results have been obtained by the addition of foreign materials such as cotton threads and glass spangles to achieve vitally new appearances. Some of these create new problems which we are confident will be worked out, and which will result in some very unusual effects. It must be kept in mind that the plastics industry moves in the same modern tempo as the automobile industry in trying to discover new materials and textures and to create new uses for materials.

Perhaps nothing in the plastics industry is so exciting as a look at new materials which are fast becoming available. Among them are the methyl methacrylate and acrylate resins. The accompanying photographs give an idea of some of the outstanding characteristics of these materials. Among the more important advantages is the beautiful clarity which is possible either by machining, pressure molding or (Continued on page 315)

Top—Automobile fittings injection molded by American Insulator Corp.  
Below—Appointments of Tenite





1



2

Acrylic resins are quite universally used for aircraft cockpits in place of glass. These in the Vultee model V-11GB attack bomber (Fig. 1) and the Curtiss Y1P-36 pursuit plane (Fig. 2) are made of Plexiglas

## PLASTICS ALOFT

by D. S. FREDERICK

LOW SPECIFIC GRAVITY AND GREAT STRENGTH per unit weight are of primary importance in materials to be considered for use in aircraft construction. As many plastics combine these essential properties, they are finding wide application in the aircraft industry.

Everyone is familiar with the doped fabric used as aircraft coverings. Cellulose nitrate was first employed as a coating for airplane fabric, but, due to its inflammability, it was gradually replaced in part by its less dangerous relative, cellulose acetate. The advent of all-metal planes has gradually forced the use of dopes to decline, although lower-priced airplanes still use large areas of doped fabric. In addition, fabrics for use in lighter-than-air craft are usually treated with dope. Laminated phenolic airplane propellers were found very suitable for use in aircraft, due to their great strength, resistance to wear and abrasion, and non-warping qualities. The use of laminated propellers has not been widespread,

due to the high mold cost and rapid change of design of air screws; however, with airplane construction rapidly approaching the mass production stage, it seems probable that laminated propellers may again be widely used.

Molded and laminated plastics have long been used in aircraft flight and navigation instruments. Plastics have also been employed in airplanes for many of the parts such as distributor heads, switches, magnetos, terminal sleeves, etc., which were actually adopted from the automobile industry. The increased employment of radio in aircraft has brought with it many plastic parts used in complicated electrical equipment. Laminated plastic aircraft pulleys have been developed which reduce friction and facilitate proper lubrication. Synthetic resin finishes are used for coating metal surfaces on airplanes, particularly where there is danger of unseen corrosion, as on the interior surfaces of metal wings.

Increased competition in airplane passenger service has

caused airline operators to improve the appearance and comfort of the cabin of passenger planes. Laminated plastics are used in decorative panels while molded plastics are employed in the lighting fixtures.

The rapid development of transparent plastic materials has been of great interest to the aircraft industry. Laminated glass has been widely employed in aircraft windows, windshields and cockpit enclosures, but the high specific gravity of glass has always been bothersome to the aircraft engineer. Very thin laminated glass was developed especially for aircraft usage. Although this safety glass exhibited great resistance to penetration, the glass itself cracked under a slight impact or pressure. Furthermore, laminated glass is not readily available in curved sections which are necessary for the reduction of wind resistance in aircraft. Laminated glass is still used in many airplane windshields, as no transparent plastic material has been developed which possesses a surface hardness equivalent to that of glass. However, most of

these windshields are made in flat sections, as curved laminated glass is quite expensive and tends to delaminate upon being subjected to weathering and vibration.

The ideal transparent material for use in aircraft would have a low specific gravity, high impact strength, hard surface, low temperature coefficient of plasticity, permanent water-white color, would be non-inflammable and could be formed easily into curved sections. Acrylic plastics possess more of these desirable characteristics than any other available material and they are being used on an increasing scale.

Before the advent of acrylic resins, the aircraft engineers were forced to employ many unsatisfactory products which were not particularly adapted for use in aircraft. Cellulose nitrate was the first transparent plastic use in aircraft, but, since it possessed the inherent disadvantages of inflammability and yellowing, it was gradually replaced by cellulose acetate. These cellulose derivatives both show limited (Continued on page 318)

This Seversky P-35 (Fig. 3) is equipped with Plexiglas as is the Beechcraft 18, the interior of which is illustrated in Fig. 4 below

3



4



# THE APPLICATION OF LAMINATED PLASTICS TO ELECTRICAL APPARATUS

by H. H. ASHINGER

THE STORY OF THE ORIGIN AND EARLY DEVELOPMENT of laminated plastics is one chapter in the history of the development of the electrical industry. Among the principal factors contributing to cheaper and better electricity is higher voltage generating and distributing apparatus. The development of this higher voltage equipment depended largely upon improvements in insulating materials.

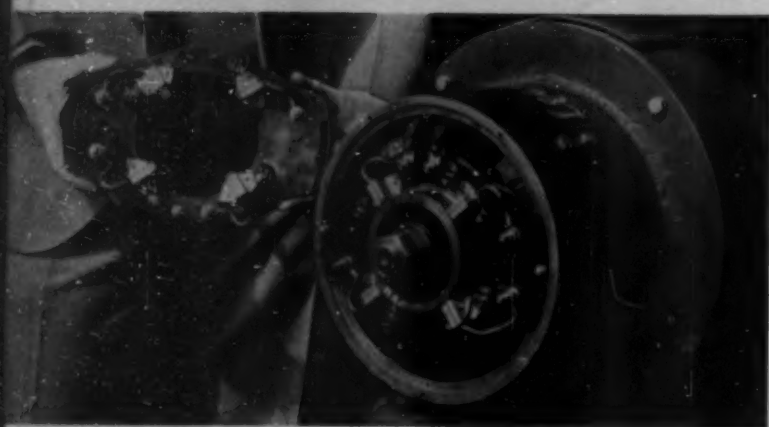
In the early days, mica, hard fiber, varnished cloth and paper were the most suitable materials for insulating purposes, with mica occupying the preferred position. However, it had serious disadvantages in size and strength since it could be secured only in small pieces and was quite brittle. It served best when built up of thin pieces placed in overlapping positions on a sheet of paper with a shellac binder. This form is still in use where mechanical strength is not important. Varnished paper and cloth were stronger and easier to handle but required mechanical support. Fiber had good mechanical strength but absorbed moisture and lost its electrical qualities. A need existed for an insulating material of good mechanical as well as dielectric strength.

About 1904, a process was invented for manufacturing a material which consisted of a filler or a series of laminations of a fibrous mixture with or without mica held together by a binder of shellac, cured under high temperature and pressure.

The process was immediately successful in the manufacture of round tubes, the material without mica soon predominating. Basically, a sheet of paper coated on one side with shellac was wound under tension on a hot mandrel. The tube was then removed endwise. Such tubes quickly became popular with engineers and have since been used extensively in electrical design. One of the more spectacular developments was the condenser bushing for high voltage transformers and circuit breakers. Porcelain bushings had certain limitations. These new laminated tubes were found to be satisfactory in thin walled sizes but heavy walled tubes for higher voltage failed through concentration of stresses at the inner and outer surfaces. It had been known that a stack of condensers in series would uniformly distribute the stress. So a thin foil was introduced in the bushing at frequent intervals as it was wound to form a stack of concentric condensers. Bushings of this type have been built for 1,000,000-volt service. Rectangular tubes were readily made by softening and forcing round tubes over a rectangular mandrel.



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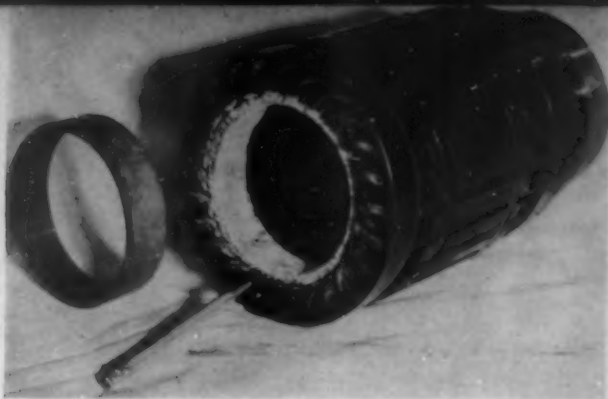


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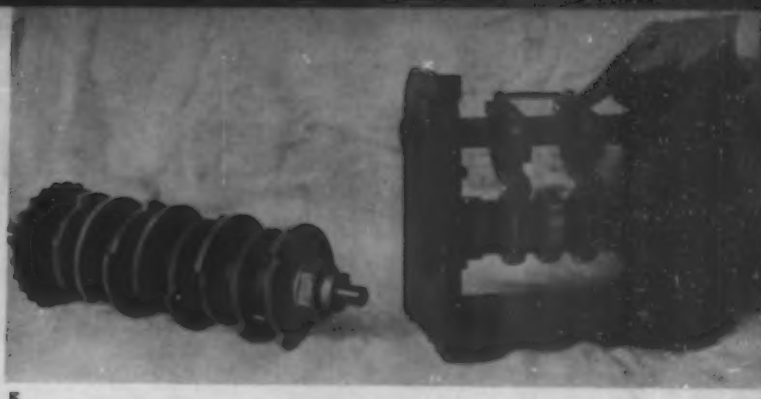


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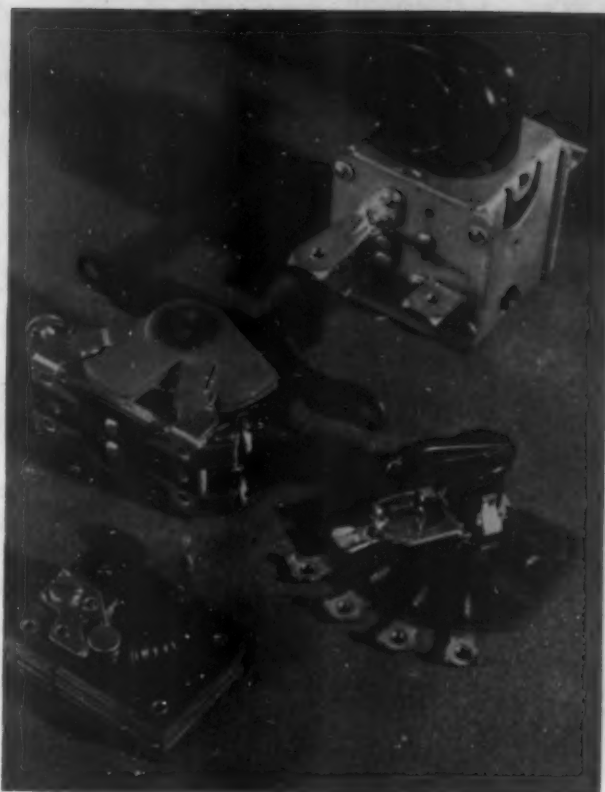
1. Boiler house control board of laminated phenolic. 2. Brush holders in motors, generators and transformers are laminated. 3. Control panels with contactors, terminals, etc., assembled in place. (All photos courtesy Westinghouse Elec. & Mfg. Co.)



4



5



6



7



8

The mechanical and electrical properties of laminated plastics make possible these controller cams (5) and slot insulation on armature (4). 6. Plastic plates for switches. 7. Coil forms. 8. Bus bars insulated with rectangular tubes and molded joints of laminated phenolic

Because of the success of the new material in tube form, the manufacture of insulating plate appeared to be a simple and logical step. However, it was discovered that plates made of paper and shellac would not stand bending stress. The laminations would split apart. Heat such as that generated in electrical machines would soften the shellac and the plates would collapse. Apparently plates of this material were impractical.

In 1907, Dr. L. H. Baekeland invented a synthetic phenolic resin which possessed qualities later found to be valuable in laminating work. This resin possessed the unique property of being first softened and then hardened by heat. One company saw the possibility of its use as a binder in place of shellac in making a heat-resisting laminated plate and started experimental work.

The new binder was first tried in tubes but results were not encouraging. The time required to harden the binder while in the tube machine was far too long even at the highest possible working temperature. The

next step was to wind and cure partially in the machine and finish curing in an oven. This solved the problem of production time but tubes blistered, layers split apart and electrical properties were poor. The new varnish appeared to be little better than shellac.

The principal ingredients were formaldehyde and phenol (carbolic acid). Formaldehyde is a gas which to be handled commercially is dissolved in water. Considerable water was left in the product in the varnish making process. Many months of work were required to devise a means of removing it and then good results were uncertain. Much more work was required to analyze and control other free ingredients in the varnish before uniformly good tubes were made.

Plate manufacture was first attempted by the tube flattening process but was not successful because the flattening operation had to be done while the binder was soft, and in that state, the adhesive strength was low. Attempts to press plates in a (Continued on page 316)

# SYNTHETIC RESINS FOR THE TEXTILE INDUSTRY

by DR. D. H. POWERS

ONE OF THE MOST INTERESTING DEVELOPMENTS which has taken place in recent years in the textile industry has been the development of synthetic resins for impregnating and finishing textile fabrics. We are all familiar with the earlier development of resin coated fabrics such as oilcloth, artificial leather, etc., where the final product was substantially a sheet of resin and the textile fabric merely acted as a backing or reinforcing base. These coated fabrics had lost all of the properties of a fabric, and had little porosity, adsorbency or softness. The recent application of resins which has made possible their impregnation into the fiber has led to the production of a fabric which looks substantially unchanged and possesses new and advantageous properties. In the past few years several million yards of cotton and rayon fabrics have been impregnated with synthetic resins and sold over the counter as improved fabrics at a higher price in new and wider markets. While the field for coated fabrics is limited, there is an extremely wide range of possibilities for these "resin modified" fabrics. Their wider adoption and general use for all types and styles of textile fabrics are dependent only on the application of the resin under the suitable textile mill conditions and on the development of improved properties in the fabric or fiber to justify the cost of the application.

## Anticrease fabrics

The most important development of synthetic resins for textiles is the anticrease fabrics which were worked

out and patented by Tootal, Broadhurst, Lee Company of Manchester, England. A number of textile finishers in this country are licensed under this patent to produce anticrease and crush resistant cottons, rayons and linens. This process consists of penetrating into the fiber the water soluble urea-formaldehyde type resin, curing the resin within the fiber and removing any excess resin from the surface of the fiber. In this process the weight of the fabric may be increased as much as 15 percent and the resilience and springiness of the fiber increased manifold. There is little increase in stiffness and no decrease in adsorbency. Dresses made of these anticrease fabrics are on the market and are particularly popular for summer wear. They may be packed in a suitcase and shaken out after a long trip, retaining their original freshness and crispness. Men's and women's rayon suitings made from anticrease and crush resistant materials are one of the most important developments in this field. These suitings are particularly cool and attractive and retain their shape and appearance after continued use. Linen suitings and dress fabrics have been anticreased and the marked demand for these fabrics has rapidly increased. There has been no question about the demand for a cool linen suiting which would not wrinkle or muss as soon as the customer learned that it was available. Spun rayon dress fabrics when properly anticreased took on the character of a fine grade worsted and had an equivalent resistance to musing. It has been shown that there was little market for many of the spun rayon fabrics unless they were given the anticrease resin treatment.

## Non-slip finishes

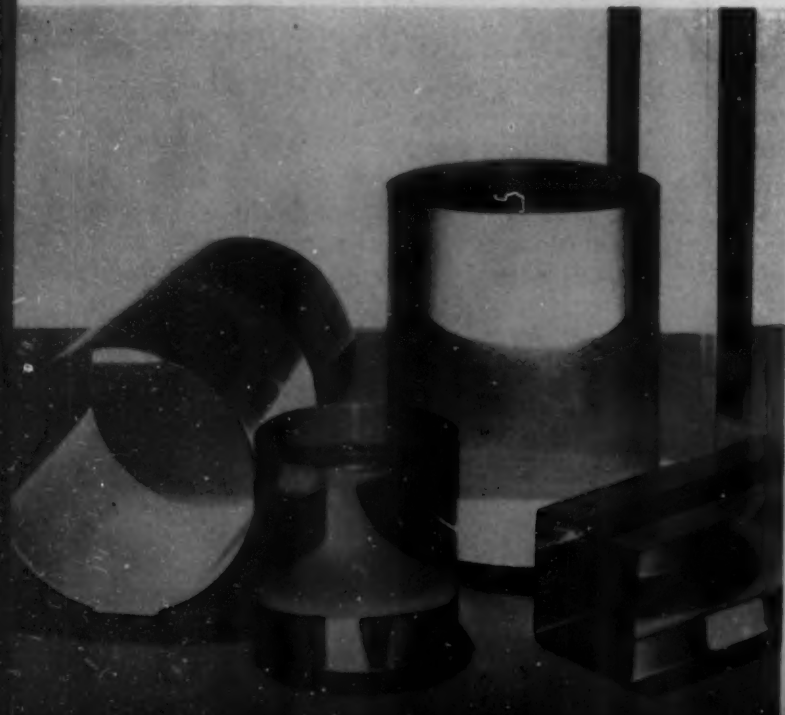
The Aspinook Company has recently patented the use of surface resins for the production of non-slip finishes. Rayon sleeve linings and coat linings were treated with a water solution of a slightly soluble resin and the warp and filling yarns were cemented together by a small amount of clear surface resin. Fabrics which had previously pulled out at the seams and slipped badly, after treatment with a small amount of resin, showed no tendency to slip and pull out and this fact widened the use and demand for this type of lining fabric. By the proper application of resin, no apparent change in appearance of the fabric was noticed with the resin application and no stiffness or harshness resulted. The development and possibilities of this type of resin modified fabric are just beginning to be recognized.

## General applications

There has been increasing interest in the use of resins for the production of permanent (Continued on page 313)

Plastics of this type in soluble form are used in the treatment of fabrics

PLEXIGLAS



# Vinylite resins

Trade Mark

An excellent base for surface coatings . . .  
forming hard and durable porcelain-like finishes

Metals coated with "Vinylite" resins can be stamped, drawn or spun without break-

ing, chipping or loosening  
**ON METAL:** this flexible, tough film.

These finishes are highly resistant to weathering agents, chemical fumes, acids, alkalies, alcohols, greases, fats and oils, and practically all corrosive agents. An unlimited variety of colors is available. Maximum adherence to metal is secured by baking. Coatings of "Vinylite" resins are used for lining metal beverage and food containers; finishes for bar fixtures, hotel, hospital, and kitchen equipment; bottle and jar caps and a countless variety of articles stamped from coated sheet metal.

The same properties which make "Vinylite" resins so highly satisfactory as a

coating for metals contribute to their excellence for  
**ON PAPER AND METAL FOIL:** paper and metal foil coatings. In addition to the resistance and non-

toxicity of the resin film, it is odorless and tasteless, and can be heat-sealed. "Vinylite" resin films are especially desirable for food wrappers and packages that must be airtight, moistureproof, grease-resistant and chemically inert. "Vinylite" resins are also used for coating and impregnating fabrics where resistance to water, oil and grease is desirable.

The alkalinity of cement, which affects other materials, does not affect "Vinylite" resin coatings. A strong, durable finish can be secured with "Vinylite" resins on concrete and asbestos surfaces, alkali composition wallboards, and in swimming pools.

Leading lacquer manufacturers have developed the formulation of these surface coatings and can furnish "Vinylite" resin finishes in commercial quantities for industrial uses. Further information will be sent upon request.



PLASTICS DIVISION

CARBIDE AND CARBON CHEMICALS CORPORATION

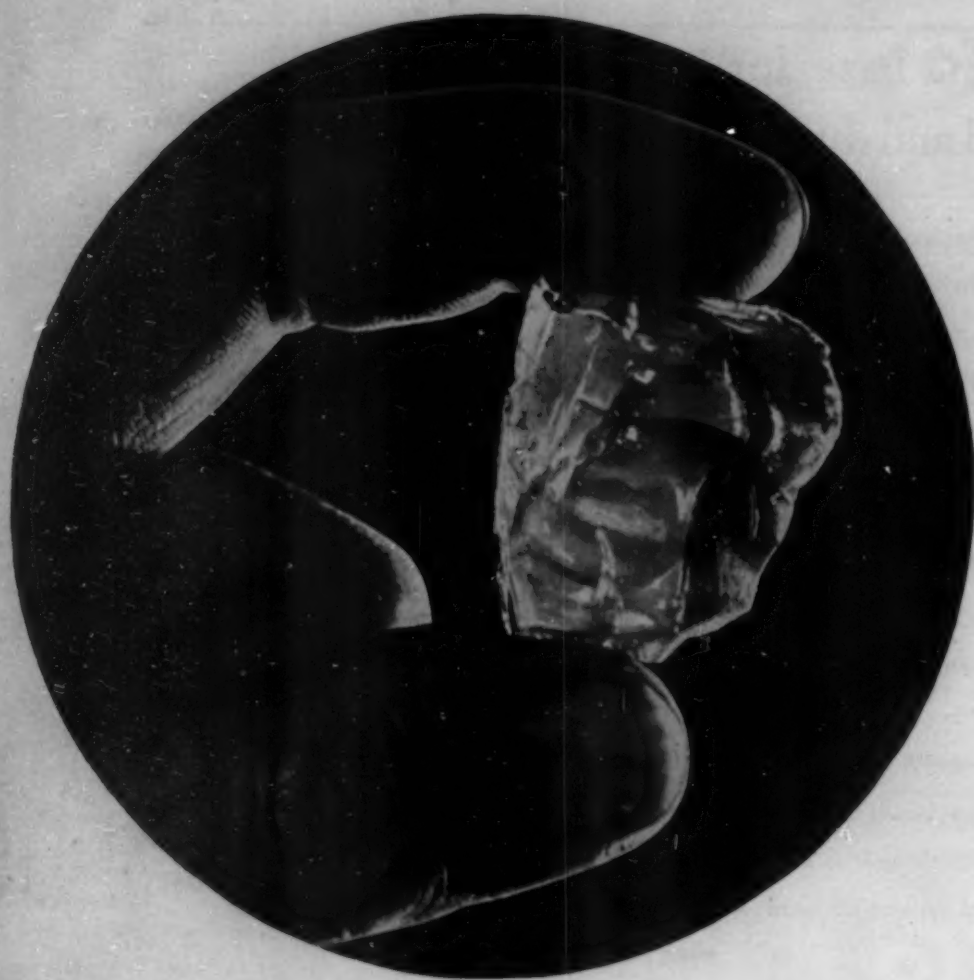
Unit of Union Carbide and Carbon Corporation



30 East 42nd Street, New York, N. Y.

PRODUCERS OF SYNTHETIC ORGANIC CHEMICALS

# JACK OF ALL TRADES AND MASTER OF EACH



**DUREZ** resins  
have countless  
uses in . . .

**AUTOMOTIVE,  
COMMUNICATION,  
BUILDING, ELECTRICAL,  
PAINT**

**AND MANY OTHER FIELDS**

## WHAT ARE THESE RESINS?

They're synthetic or artificial gums built up from chemicals. Durez resins are phenol-formaldehyde derivatives which set infusibly by chemical reaction—not mere oxidation. They are used for such diverse purposes as bonding metal to wood or rubber; impregnating pulp, fabrics, asbestos; protective coatings for wire, metal, rubber, wood, composition; for insulating, sizing, bonding, acid and waterproofing.

## WHAT DO THEY DO?

The jobs that a Durez resin can do are almost unlimited. Used to impregnate brake linings they lengthen life, end squeaks. They waterproof paper and cardboard containers. They are used to impregnate noiseless, long-wearing fabric gears. To plywoods they

impart resistance to moisture, vermin and fungus growth. Applied to a variety of materials, they add

## RESISTANCE TO

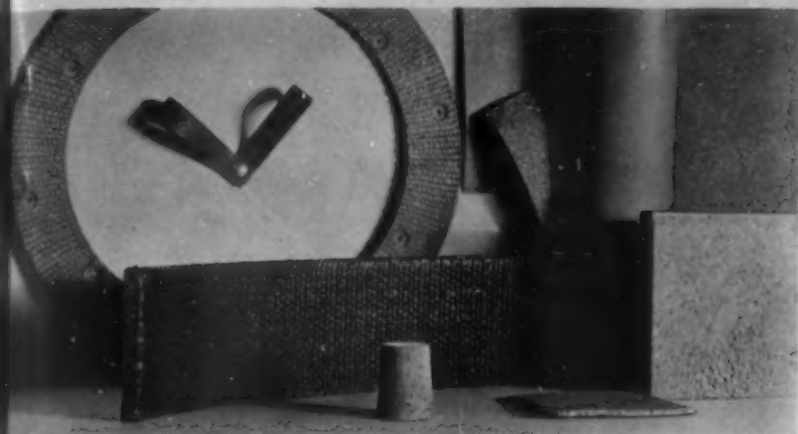
|          |                 |
|----------|-----------------|
| SOLVENTS | FRICTIONAL WEAR |
| OIL      | HEAT            |
| GREASE   | ACIDS           |
| CAUSTICS | ELECTRICITY     |

*There are over 100 Durez resins, each designed for a specific use. In our many years of research and experiment we have accumulated data on a wide variety of applications. Feel free to write us in complete confidence so that our experience and yours may be combined to mutual advantage. Our laboratory staff is ready to cooperate on specific applications involving synthetic phenolic resins. In writing, give as much information as possible. Address General Plastics, Inc., 710 E. Walck Road, North Tonawanda, N. Y.*

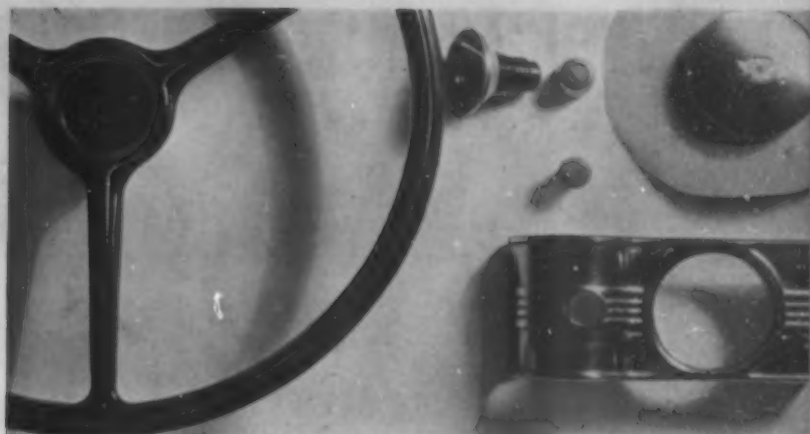
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## How Durez resins are being used to produce a better product



**FOR IMPREGNATING...** Durez resins impregnate paper and fabrics, make sheet laminated material that is dielectric and resistant to water, solvents, mild acids and alkalis. They reduce the porosity of metal castings. They impregnate flexible woven belting, make it strong and long-wearing. Brake linings show longer wear and a more uniform friction coefficient when impregnated with Durez resins. Silent gears and bearings, that never need oiling, are made with Durez resins. They impregnate wood, make it stronger, give it a smoother finish.



**FOR COATINGS THAT MUST WITHSTAND SEVERE SERVICE...** Durez resins coat hard rubber steering wheels, give them resistance to abrasion and perspiration. They are used in the rayon industry to coat metal parts in contact with chemicals, and prevent corrosion. They coat paper textile tubes, prevent bleeding, and enable them to withstand the action of water, dyes, bleaches and chemicals. They make excellent coatings for porous materials, such as paper, composition board and concrete. The hard, flexible coatings will last indefinitely.



**FOR BONDING...** Durez resins bond plywood, veneers, high speed grinding wheels, giving them strength, resistance to frictional wear and heat. They bond graphite to form long-wearing commutator brushes that will not soften under heat. They are used for fixed resistance units, the resins acting both as a bond for the inert filler and supplying the necessary electrical resistance. They bond sand cores, make possible the production of smoother, less porous metal castings.



**AS ADHESIVES...** Special Durez resins have been developed for binding bristles in brush backs and steel paint brush ferrules. They cement molded plastics or composition together... fasten glass bulbs to composition or metal sockets. They bond rubber and wood to metal. They make flexible abrasive cloths and waterproof sandpaper. Durez resins produce a strong, permanent bond that is resistant to oil, solvents, soaps, mild acids and alkalis.

Durez resins are one of the most versatile of man-made products, with thousands of industrial applications. Have you any uses—present or potential—for these resins in your plant? Why not find out?... Write us today.

★

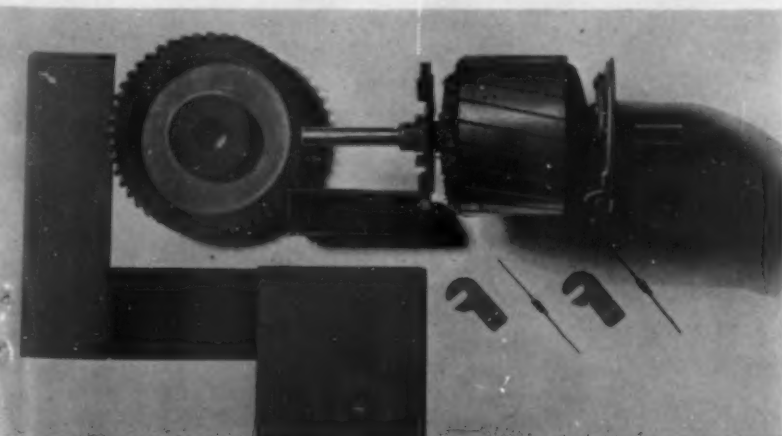
# DUREZ

POWDERED - SOLUTION - COLLOIDAL

*RESINS*

SEE DUREZ ADVERTISEMENT ON PAGES—302-303

**FOR INSULATING...** Durez resins impregnate the armatures of electric motors that must withstand severe service. Here they provide high insulation, strong mechanical bonding and resistance to water, oils, heat and chemicals. Durez resins coat wires, coils, and numerous other electrical parts that must have high insulation value.



# TYPICAL INJECTION MOLDING APPLICATIONS

by C. H. PENNING

PROOF OF THE VERSATILITY OF PLASTICS SEEMS to be unending. Several years ago, when everybody was depressed, some in the industry thought that nearly everything that could be molded had been molded. Then along came new products and new methods, widening the range of activity almost beyond the dreams of the most imaginative feature writer.

Undoubtedly the factor of greatest influence in projecting the plastics industry into new fields has been the development of the injection molding process for thermoplastics. Here are presented a few photographs illustrating some of the applications which have been made not only possible but practical by this new process.

Fig. 1 shows examples of one of the many designs of automobile handles being molded by Die Casters Pty., Ltd., of Australia in German injection machines. One of these handles is being used on the 1937 Studebaker in Australia. The sectional view shows the construction—a zinc die casting, with an injection coating of cellulose acetate. Handles similarly made are standard on practically all other Australian motor car models, which also carry internal dome lamps, switch plates, visor brackets and assist grip hangers of thermoplastic.

The displacement of chrome-plated castings by plastic-covered hardware has enabled Die Casters Pty., Ltd., to handle with twenty polishers an amount of work which

would otherwise keep 55 men busy on the polishing operation alone.

Another interesting operation of this organization is the equipping with injection-molded parts of the new streamline trains being built by the Australian Government Railways as part of a new expansion policy. These trains are reputed to be superior to even the latest American trains now on the rails and the plastic fittings are certain to be given world-wide publicity.

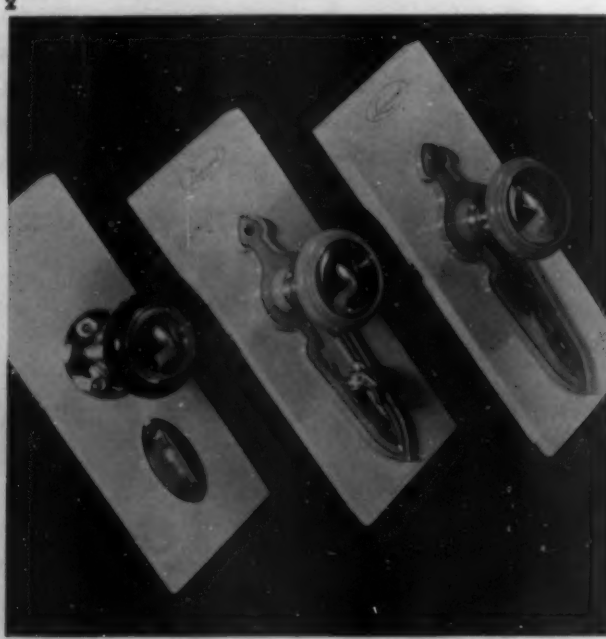
Lockwood Hardware Manufacturing Company has chosen the same plastic material for the knob bodies and escutcheons of its new "Patrician" line of hardware (Fig. 2). The knobs can be taken apart and the bodies changed in color as desired. Thus when the color scheme of a room is changed it is possible to make the hardware match simply by purchasing a new knob body and escutcheon. Certain colors have been selected as standard but any color or color combination may be obtained on special order. Commonwealth Plastics Company is molding these pieces on injection machines of their own design.

Another and possibly more obvious use of injection-molded hardware for household use is in the bathroom and kitchen for faucet and other control handles. Hardware engineers throughout the world have been trying to devise processes that will give a warmer and more color-

Fig. 1. Automobile door handles injection molded of Tenite over a metal core by Die Casters, Ltd. for Australian models of the 1937 Studebaker. A sectional view of this application is shown in the foreground



Fig. 2. Door knobs and escutcheons injection molded by the Commonwealth Plastics Co. for the Lockwood Hardware Manufacturing Co.



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*Ideal for jars, bottle caps, ash trays, trade-marking, dials, signs, displays, etc., etc.*

## ANIGRAPHIC PROCESS, INC.

305-313 E. 45th St., New York

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Fig. 3. Tenite frames molded around glass for 1938 model RCA-Victor Radios. Molders, Erie Resistor Corp. and Mack Molding Co. Fig. 4. Motorola Radio fittings injection molded by The Gits Corp. Fig. 5. Injection molded control knobs for automobile radios and heaters, showing a variety of coring methods. (Photos courtesy Tennessee Eastman Corp.)

ful finish than that of chromium and nickel, without the hazard of breakage inherent in porcelain or glass, and the plastic-covered die casting appears to be the answer. It is not merely a surface finish. The acetate plastic coating usually has a thickness of 0.050 inch or more. In itself, this coating is strong, tough and resilient, and with the added strength of the metal core it has all of the desirable qualities for hardware and furnishings. The range of effects achievable is almost unlimited and includes transparent, translucent, opaque and pearl, as well as standard bathroom and kitchen accessory colors proposed by the National Bureau of Standards and

recently adopted by the trade. The lustrous colors and the tactile qualities compared with metal should make such fittings readily accepted.

Last year the circular bezel molded around a glass lens by Erie Resistor Corporation for Colonial Radio Corporation won an award in the Industrial Group in the MODERN PLASTICS Competition. This year acetate frames injection-molded around glass have been adopted by RCA-Victor on practically its entire line of radios, the various types of frames being molded by Erie Resistor Corporation and the Mack Molding Company. (Fig. 3.) The rich colors of the molded pieces blend with the attractive cabinet woods, making assemblies with appearance far superior to that possible with metal. Sales of the new models during the few weeks they have been on view have been very pleasing to the manufacturers.

This new method of molding around glass has, of course, many other applications aside from the radio field. The round bezels could be applied to dial covers for speedometers, clocks and other instruments, the rectangular as well as the circular to picture frames, mirrors, etc. The practical advantages are obvious—an air- and dust-tight joint, eliminating possibility of rattle; less likelihood of breakage during assembly and repair; decreased cost of assembly; and improved appearance of the finished article.

Fig. 4 shows seven parts of the Motorola automobile radio molded by Gits Corporation for Gavlin Manufacturing Corporation. The large black piece is a topper antenna receptacle, used on Ford cars only. The other black parts are topper antenna coupling bushing and insulators. The circular piece in the center is easily recognized as a drum dial. The remaining two parts, in duplicate, are tone indicators and dial pointers.

Fig. 5 shows an assortment of control knobs as used on automobile radios, heaters, etc. A wide variety of coring methods is exhibited. This coring not only decreases the quantity of molding composition required but increases the output with any machine. Depending upon the capacity of the specified make of machine, knobs such as these can be produced at the rate of 720 to 1080 an hour, using 4 to 6 cavity molds. Such coring also eliminates the possibility of shrink marks which might appear on the top surface of these knobs were they injected as solid pieces.

While the increased detail of the core increases the cost of each cavity, as compared with uncored pieces, the decrease in number of cavities required and the material saved more than compensates for this and makes economically possible short runs which would not even be considered as compression molding jobs. The 24- to 48-cavity mold for small pieces of this sort is rapidly becoming a thing of the past.

At present, the limit in weight of injection-molded pieces is approximately four ounces. The prediction is made, however, that before long machines will be made and in operation capable of injecting a pound or more at a time, in rapid succession, so that articles of substantial size can be made or covered by this method. This again will widen the field for thermoplastics.

## SYNTHETIC RESINS FOR THE TEXTILE INDUSTRY

(Continued from page 306) finishes for all types of textile fabrics to replace the finishing oils, starches and gums which are removed in a single washing. These resins, in addition to giving a finish with greater permanence, frequently add to the character of the fabric, reducing its shrinkage, increasing its brightness and giving it a more attractive tactile finish. There would not have been any interest in these resins for the finishing of fabrics if they had been supplied in an organic solvent solution since the textile finisher could not handle them in this medium. It was necessary to develop resins which could be applied in aqueous solution or aqueous dispersion, and which would be readily fixed in the fiber without special equipment or special processing technique.

### Type of resin required

In considering the conditions to be met by the resin manufacturer in processing a resin suitable for general textile application, the following characteristics are important:

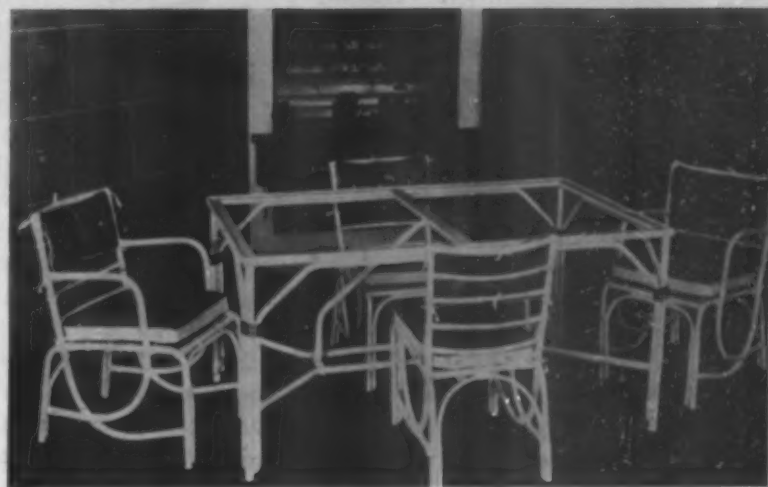
- (1) Absolute freedom from color
- (2) Absolute freedom from odor
- (3) Resin fastness to washing and soaping
- (4) Stability to light
- (5) Absence of embrittling action
- (6) Absence of tendency toward stickiness or tackiness

While there is a limited use for *colored* resins or resins that are a very pale yellow, general application to textile fabrics requires an absolutely colorless product. All printed fabrics and plain shades are produced to match color standards which cannot be varied. Any product which decreases brilliancy or dulls the ground shade could not be considered for general use. In fact, it has been found that a clear glass-like resin is necessary to maintain the brightness and clarity of the fabric colors.

There is little need to expand on the question of odor. It should be pointed out, however, that textile fabrics are usually rolled in tight rolls and stored in confined or hot places for long periods of time. It is absolutely essential that no odor develops in these fabrics under these extreme conditions. A slight residual odor will offset any advantage a resin may impart to a fabric.

The fastness to washing is an extremely difficult specification to meet and it has been frequently found that resins which are alkali insoluble when cast in a sheet form will not be fast to an alkaline soap solution when impregnated in a fiber. This is due to the fact that finely dispersed resin offers a far greater surface to the soap solution and it is much more readily attacked by acid or alkali. It is also important that the resin flow into the fiber to obtain reasonable wash fastness. A resin which is completely insoluble in soap solutions will not be fast on the fabric unless it is firmly fastened to the surface or deeply imbedded between the fibers.

Just as the resin must not affect the shade of the vari-



REVOLITE

Typical uses of resin treated fabrics in decoration

ous fabrics, it is essential that the resin shall not change the shade on exposure to sunlight. Cotton fabrics, particularly in the drapery field, must withstand continued exposure to direct sunlight and any resin which darkened or changed its cast under such exposure will be unsuited and eliminated. In this connection, the acrylate resins (see article "Acrylic Resins" elsewhere in this issue) are admirably suited for this type of development as they are absolutely colorless and light stable.

It is particularly significant to note that even the hardest and most brittle resin when properly impregnated into the fiber does not give a brittle fabric. If the proper impregnation of the resin into the fiber can be developed, the hardest and most brittle resin will give a soft, non-brittle fabric. On the other hand, if only a surface coating of this brittle resin can be obtained, the fabric is greatly stiffened and its tensile strength is substantially reduced. A surface application of a brittle resin will destroy the usefulness of a fabric due to the ease with which the fine fibers can be broken and frayed under abrasion.

If a soft or sticky resin is completely impregnated with the fiber the resin treated fabric will show no tendency toward tackiness or stickiness. The soft resins give the fiber an improved fullness, resilience and body which are extremely attractive and valuable on many dress and suiting fabrics. However, it has been shown that it is much more difficult to satisfactorily penetrate this class of resin into the interstices of the fibers. These resins

should not be applied to the surface of the fibers as they will give a greatly reduced but definitely tacky effect.

#### Plant conditions required

The application of synthetic resins for textile application has required the development of products to fit mill conditions. Some of the problems that have arisen in this connection are the following:

- (1) Application in aqueous solution
- (2) Ease of fixation
- (3) Stability of solutions
- (4) Adsorbency of finish

The application of the resin in aqueous solution is important not only from a point of view of eliminating the cost of an organic solvent, but more especially because it ensures the application of a resin which will penetrate into the fiber. The use of water as a solvent or dispersant also eliminates the inflammable solvents which are a fire hazard and saves the cost of a solvent recovery unit. When the resins are applied in aqueous solution, a method must be worked out for quickly making them insoluble and wash-fast after they have been put on the fiber. A thermosetting process is generally used for insolubilizing the molding resins. A combination of high temperature and pressure with a suitable catalyst is frequently required to convert the resin into a completely insoluble form in a few seconds. But the pressure involved may be several tons and the temperatures required are usually from 300-400 deg. F. For

the general textile application such temperatures and pressures are out of the question and it has been necessary to work out a catalyst which will effect a curing of the resin at temperatures as low as 230 deg. F. and without the use of any pressure.

One of the serious problems in resin manufacture for textile application has been the production of stable resin solutions. By their very nature, they are products which can be quickly converted to insoluble masses. It is, consequently, extremely difficult to isolate and hold them as completely soluble products in such a condition that they may be stored for weeks and months without any change whatsoever. Any decrease in solubility entirely alters or destroys their value for textile use. The resin manufacturer has come a long way in the recent production of a soluble resin form which can be stored for months with substantially no change and yet will still change to a completely insoluble form when cured at low temperature for 60 seconds.

It is important to note that the adsorbency of a fabric may not be materially affected even when impregnated with a completely insoluble resin. This occurs only when the resin is impregnated into the fiber, the same resin on the fiber will give a completely water insoluble finish. The resins to be wash-fast must be insoluble, but they decrease the adsorbency only when they coat the yarns. It is particularly significant to note that the wet strength of rayon yarns may be greatly improved by proper resin impregnation.

#### Future for resins in textiles

It is clear from the foregoing that relatively few resins are of general interest or value for textile fabric modification. The limitations of color, light stability, freedom from odor and ease of curing rule out many entire resin classes. However, for those resins that can be applied, a wide and growing market opens. It is probable that most of us are using or wearing today fabrics which contain unsuspected concentrations of resins. These resins have not been used as weighters or fillers but because they contribute and build into the fabrics new or added characteristics. The resin modification of textile fabrics is making possible the transmutation of fibers—conversion of rayon fabrics to materials with all the properties of a silk material. The conversion of a cotton suiting to resin modified wool-like garment is no longer a dream but an actuality. Here is a field where the resins owe their progress and development to their ability to hide their identity and to submerge their characteristics within those of the textile fiber or yarn. But by that very subservience they have gained a greater market and far wider use. Today, resin modified vegetable fibers compete and replace unmodified animal fibers and resin modified animal fibers regain a part of their lost markets. By increasing elasticity and by increasing luster; by decreasing shrinkage and by decreasing slippage, by increasing strength and by decreasing wear, the use of resin in textiles is amply justified and a new field for resin application is opening which promises to be one of its largest opportunities.

Resin treated fabrics make porch furniture impervious to moisture and add permanence to bridge table covers where drinks are served



★  
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OF TOMORROW**

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**DECEMBER  
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**PLASTICS AND THE MOTOR CAR**

(Continued from page 301) injection molding followed by polishing. One look at their wonderful transparency leads us to give consideration to the many uses to which they can be put.

Another outstanding quality of these transparent resins is that they show more resistance to ultra-violet light than any plastic yet made. This leads to the use of this material for the adornment of the exterior as well as of the interior of the car. Besides being perfectly clear, the materials lend themselves wonderfully to both transparent and opaque color. In addition, they will not absorb water, making them all the more available for outside use. They are resistant to cold and heat such as might be experienced in various climatic conditions. At the present time these materials seem to be particularly well adapted to the manufacture of tail light lenses, head-light lenses and radiator ornaments. Their possibilities cannot be overlooked.

Among the developments that may be seen within the near future will be the growing use of plastics in instrument panels and garnish moldings, which are the principal decorative features of automobile interiors. Within the next year or so, very large pieces of instrument panels are expected to be successfully molded from plastics. There is no question that cellulose acetate will continue

in increasing use for these larger applications, because it has considerable strength and is satisfactorily resistant to extreme cold and heat. Another outstanding attribute is that the finish is self-contained and solid throughout the material.

It is our belief that, as fast as present problems in connection with new materials can be worked out, the public will stand ready to welcome any use in the automobile that can be made of plastics. The public has been educated in the outstanding advantages of plastics through the sale in stores and elsewhere of thousands of articles made from these materials, pieces that usually are novelties and which have no connection whatever with the automobile. The use of plastics has become so connected with everyday life that they no longer are a novelty and are taken for granted.

Market breakdowns reveal that the women of America are influencing in a major degree the further and broader use of color, not only in the motor car, but in almost everything else. This fact is a happy one, indeed, because the chief beauty of plastics is derived from the wide number of colors available. Perhaps no material, or combination of materials and finish presents a brighter future than that of plastics. Present accomplishments, and accomplishments on the verge of achievement lead persons intimately familiar with these materials to believe that eventually it will be possible to mold almost any article from plastics.



9



10



11



12

9. Laminated tube stock is used for radio coils while laminated flat stock (10) is punched and printed for sockets, terminals and dials. 11. Micarta bearings for farm machinery. 12. Special shapes for motor housings which require high mechanical and electrical properties are produced in special molds

## APPLICATION OF LAMINATED PLASTICS IN APPARATUS

(Continued from page 305) flat position resulted in the varnish sticking to the press tighter than to the paper. This difficulty was overcome by the use of an untreated sheet on either side of the plate, but resulted in a poor surface finish. A solution was found in the use of high resin content surface sheets together with highly polished metal pressing plates to which the varnish not only did not stick but acquired the high gloss of the metal plate. The result was a heat-resistant, moisture-resistant plate of high mechanical and dielectric strength which has since been used extensively as electrical insulation.

Up to 1914, little thought was given to the use of phenolic laminated material for other than insulating purposes. At that time, an engineer was troubled by the noise in the gear train on an experimental automobile generator. To eliminate the noise, rawhide and hard fiber gears were tried unsuccessfully. In the search for something better, the new material was tried with highly successful results. Its light weight, great

strength and quietness in operation made it an excellent gear material.

More recently, a wide diversity of materials and modifications in the original process provide a very wide range of desirable properties. Because of the wide choice of fillers, binders and processes, the properties of laminated materials may be varied through quite a wide range to suit the requirements of various applications. Certain properties, however, are opposed to others and cannot always be combined in one grade of material. Consequently, there have been developed certain standard grades possessing different properties according to application requirements. Special grades are developed to meet special requirements. The qualities of lightness, strength, machinability, insulating qualities, good appearance exist in all grades.

Laminated plastics are made in a number of different forms, chiefly plates, rods, tubes, angles, channels and special shapes. Manufacturers of these materials have adopted standard specifications covering the more important properties of the various grades.

TABLE OF NEMA STANDARD SPECIFICATIONS

|   | Paper Base Grades |         |         |         |        | Fabric Base Grades |        |        |
|---|-------------------|---------|---------|---------|--------|--------------------|--------|--------|
|   | X                 | P       | XX      | XXX     | C      | CE                 | L      | LE     |
| Tensile Strength, lbs. per sq. in. ....     | 12,500            | 8,000   | 8,000   | 7,000   | 10,000 | 9,500              | 10,000 | 9,000  |
| Flexural Strength, lbs. per sq. in. ....    | 21,000            | 15,000  | 16,000  | 15,000  | 20,000 | 19,000             | 20,000 | 19,000 |
| Compressive Strength, lbs. per sq. in. .... | 35,000*           | 25,000* | 34,000* | 32,000* | 38,000 | 36,000             | 35,000 | 37,000 |
| Dielectric Strength, volts per mil. ....    | 700               | 600     | 700     | 650     | 150    | 425                | 150    | 500    |
| Moisture Absorption, percent. ....          | 4                 | 4       | 1.3     | 1.0     | 1.7    | 1.5                | 2.0    | 1.2    |
| Power Factor, percent. ....                 | .....             | .....   | 4.5     | 3.5     | .....  | 5.5                | .....  | 4.5    |
| Specific Gravity. ....                      | 1.35              | 1.35    | 1.35    | 1.32    | 1.38   | 1.34               | 1.36   | 1.35   |

\* These figures are values of one manufacturer.

# DESIGN FOR PLASTICS

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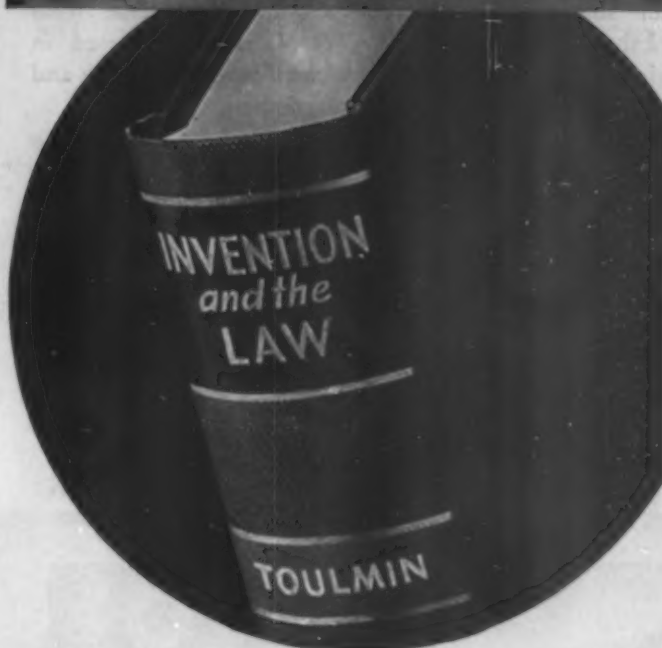
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## PLASTICS ALOFT

(Continued from page 303) stability toward aging and weathering, and have a tendency to warp and shrink. Since the cellulose plastic sheets are manufactured by slicing them from large blocks, the knife marks from the sheeting operation reappear when the sheets are heated for forming. Transparent alkyd resins made from phthalic anhydride and glycerol have been used in aircraft in England, but lack the desired flexibility and are too brittle to be entirely satisfactory.

Cast acrylic resin sheets give the aircraft industry a plastic material better adapted for use in aircraft windows, windshields, cockpit enclosures and gun turrets. The acrylic plastics possess all the characteristics of the ideal transparent aircraft material with the exception of a glass-hard surface. Although the acrylic resins are not as hard as glass, they are considerably harder than the transparent plastics which have previously been used in aircraft.

The physical data included in the Plastics Properties

5. Curved Plexiglas gun turret and top for pilot's cockpit. 6. Control pulleys of laminated Micarta

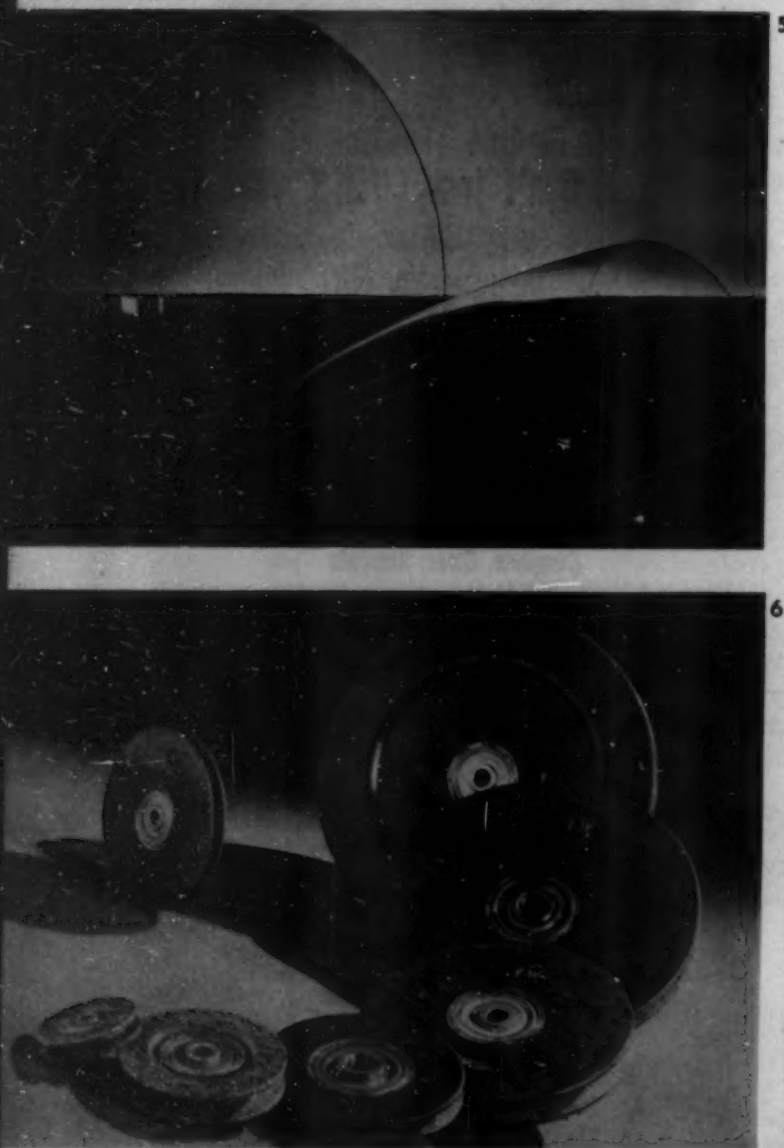


Chart at the end of the Materials Section make evident the excellent physical properties of the acrylic plastics which make them suitable for use in aircraft.

The acrylic plastics are remarkable in respect to their crystal-clear transparency. They are outstanding in their resistance against aging and sunlight. As they are made without the use of plasticizers, they do not warp or shrink. For this same reason, they also exhibit a low water absorption. Although they will support combustion, they burn only slowly after they have been ignited by prolonged heating with a free flame.

Since they are thermoplastic, acrylic sheets may be formed into curved surfaces by the application of heat and a slight pressure. As the sheets are cast, their plane surfaces do not become ridged when pieces are heated prior to forming. The softening point of these plastics, 180 deg.-200 deg. F., is high enough to prevent their losing shape when exposed to the sun, yet low enough to permit their being formed without the necessity of using excessively high temperatures. The high heat distortion point of acrylic plastics also makes them suitable for use in landing light covers.

The acrylic resins are available in sizes as large as 36 in. by 48 in., affording the aircraft engineer the opportunity of using large transparent areas without vision-obstructing frames. The excellent machining properties of the acrylic plastics make it possible to saw, drill or mill them exactly. As the impact strength of these materials is relatively constant over the temperature range from 40 deg. to 160 deg. F., they do not become brittle at the low temperatures encountered at high altitudes.

The increased interest in flights at high altitudes where wind resistance is greatly reduced has necessitated finding a transparent sheet material which will resist pressures, as the air pressure inside a stratosphere plane is kept considerably higher than the external atmospheric pressure at great heights. The acrylic plastics are suitable for use in stratosphere planes as their extraordinary transparency enables their use in thick sections. Bursting tests on flat acrylic disks have shown that circular pieces  $\frac{3}{8}$  in. thick and 12 in. in diameter will not fail until a 62 lb. per sq. in. difference in pressure on the two plane surfaces has been attained. Disks of  $\frac{1}{2}$  in. thickness and 12 in. dia. do not fail under a pressure differential of 100 lb. per sq. inch.

The recent rapid advancement in the development of transparent plastics gives the aircraft industry good reason for expecting that their long wished for ideal material may soon be attained. When one considers the increased production and application of large molded plastic sections, it may not be too fantastic to predict the future construction of airplanes in which many structural parts will be made from plastic materials.

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by CARLETON ELLIS

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## NOMENCLATURE

by CARLETON ELLIS

IN THE RAMIFICATIONS OF THE PLASTICS INDUSTRY many fields are touched upon. The binder is a resin or resinous composition which brings in chemistry, particularly colloid chemistry. Compounding the binder with fillers (if used) and auxiliaries is the next step. Planning appropriate molding equipment and properly molding the material to form a finished article is still another arena of specialized technique; and finally testing to see whether the product is fit for a particular use. Each step includes a separate art and nomenclature. To cover the entire series must perforce be made up of terms taken from the individual fields. The following is a

selected list of terms in glossary form designed to touch upon the whole.

**Alkyd resin**—Any condensation product involving a polybasic acid and a polyhydric alcohol. Typical examples are phthalic glyceride and its modifications containing combined fatty acids or rosin. Representative examples are Rezyls and Glyptal.

**Aminoplast**—General terms for synthetic resins from amino or amido compounds. A typical example is urea-formaldehyde.

**Amorphous**—Devoid of crystalline structure. This condition is rare. Many substances which are apparently

amorphous show microcrystallinity, particularly under x-ray examination.

**Artificial rubber**—Products possessing the physical properties of caoutchouc. Neoprene, Thiokol and the German butadiene product, Buna, are examples.

**Asphalt**—A dark-colored, viscous to solid hydrocarbon complex including: (a) The easily fusible bitumens often associated with a mineral matrix, not having a waxy luster or unctuous feel; (b) fusible residuums obtained from the distillation, oxidation, etc., of bitumens.

**A-Stage resins**—Thermosetting resins reacted only to the initial stage where they are soluble and fusible. The normal stage of a resin used for impregnation.

**Balsams**—Natural vegetable exudations consisting of resins mixed with volatile oil. The name is also applied to products having the physical characteristics of the natural balsams but produced by reactions which normally lead to resinous materials. For example, Rezyl Balsams.

**Bitumen**—A naturally occurring or pyrogenous hydrocarbon complex insoluble in water but soluble in carbon disulphide. Color and hardness variable.

**Bonding strength**—The amount of adhesion between a binder and filler. More specifically, the measure of the extent to which the composite layers of a laminated product are bonded together.

**Brittleness**—Liability to break, generally to a conchoidal fracture.

**B-Stage resins**—Thermosetting resins reacted to a stage where they soften when heated and swell in contact with liquids but do not entirely fuse or dissolve. This is the preferred stage for the resin in molding compositions.

**Bulk factor**—The ratio by volume of the loose molding powder to the resultant finished article.

**Casting**—Forming a material into a shape by pouring it when liquid into a mold. The product from the mold is used as such or mechanically worked in various ways to the final articles, as by sawing, cutting, blanking, turning, drilling, forming, swaging, grinding, polishing, sanding or routing.

**Cold flow**—Change of dimensions or distortion caused by sustained application of a force greater than the elastic limit. Cold flow is generally low with thermoset products but is often appreciable and serious with thermoplastics. A high softening point generally reduces cold flow but at the same time makes molding more difficult.

**Cold molding**—A procedure in which a composition is shaped at ordinary temperatures and hardened by subsequent baking. Practiced particularly with asphalt-drying oil compositions containing asbestos filler to yield articles of high heat resistance.

**Colloid**—Any substance when dispersed into particles whose size ranges between 5 and 100 millimicrons. Molecules of many synthetic resins fall within this range.

**Compressive strength**—Resistance to deformation under applied pressure.

**Condensation**—A chemical reaction in which two or more molecules combine with separation of water or some other simple substance. Applied to synthetic resins

it means the formation of a resin by combination of a number of molecules with elimination of water, ammonia, hydrogen chloride or other simple substance. Examples of condensation resins are alkyd, phenol-aldehyde and urea formaldehyde resins. The final products are also called condensation-polymers. *See Polymerization.*

**Co-polymerization**—The term applied when two or more substances polymerize at the same time to yield a product which is not a mixture of separate polymers but a complex having properties different from either polymer alone. For example, Vinylite is produced by polymerization of a mixture of vinyl acetate and vinyl chloride.

**C-Stage resins**—Thermosetting resins in the final stage in which they are infusible and insoluble. The state of the resin in the final molded article.

**Curing**—The change of a binder from the soluble-fusible condition to the substantially insoluble-infusible form by chemical action. The heat-setting of a resinoid. Action is analogous to vulcanization of rubber.

**Densification**—Any procedure applied to a molding powder to lower its bulk factor.

**Dielectric strength**—Voltage gradient at which a continuous electrical discharge will take place between two electrodes when the material in question is placed between the electrodes and a potential difference is applied to them.

**Elastic**—A substance which exhibits rubber-like properties or "high elasticity" over a wide range of applied forces.

**Elastic deformation**—When a substance reverts to its original dimensions on release of an applied stress.

**Elastic limit**—The point at which a body begins to yield under a stress; that is, when the stress is equal to or greater than the internal friction.

**Elasticity**—The property by virtue of which a body reverts to its normal bulk or shape after deformation by an applied force.

**Eucolloids**—Linear polymers of a degree of polymerization over 1000; that is, each molecule is made up of over 1000 units of a simple substance. They show pronounced swelling and their solutions are highly viscous. The solid eucolloids are very tough and hard.

**Extrusion molding**—A molding procedure for extended shapes of uniform cross-section, whereby a heat-softened substance is forced through an orifice of form coinciding with the cross-section of the article.

**Filled-products**—Molding compositions or molded products containing fillers.

**Flash mold**—A mold designed to permit excess molding material to escape during final closing.

**Flexibility**—Capability of bending without breaking.

**Flexural strength**—Resistance of a substance to bending.

**Fluidity**—Reciprocal of the viscosity.

**Gel**—A somewhat rigid, generally transparent, two-phase liquid-solid system in which the solid is precipitated as aggregates in and around which the liquid is held.

**Gelation**—Formation of a gel.

**Gums**—Viscous vegetable secretions which harden but,

unlike resins, are water-soluble. The name is often applied, particularly in the varnish industry, to natural resins such as copals.

**Hardness**—Property of substances determined by their ability to abrade or indent one another. Often measured by the extent or depth of indentation produced by a standard substance under a predetermined load.

**Hemicolloids**—Polymers of molecular weight up to 10,000, corresponding to an order of polymerization equal to 20 to 100 monometric units. They dissolve without swelling and give solutions of low viscosity. Precipitation from solution yields powdery masses.

**Hot molding**—The process of converting a composition into an article of desired size and shape by heat and pressure.

**Impact strength**—The measure of toughness of a material. Generally determined by the energy required to break a specimen in one blow.

**Injection molding**—A molding procedure whereby a heat-softened plastic material is forced from a receptacle into a cavity which gives the article of desired shape. Used particularly for thermoplastics since the scrap can be re-used. As soon as the composition in the mold cools sufficiently to be rigid, the mold is opened and the molded article removed. An analogy of injection molding in another field is shown by the linotype machine.

**Inserts**—Parts of a finished molded article which are of different material from the molding composition but are set in place or positioned by the molding operation.

**Jelly**—A material of soft homogeneous consistency usually transparent and quivering when shaken. See *Gel*.

**Laminated products**—Sheets of material united by a binder. For example, sheets of paper or wood coated and/or impregnated with a resinous composition and subjected to pressure, generally with heat.

**Elastic**—A substance which at a certain temperature exhibits the physical properties of rubber. Unlike a viscous liquid, stress causes deformation at this temperature but removal of stress results in substantial recovery of the original shape.

**Linear molecule**—A molecule of highly elongated form. Generally applied to straight-chain polymers.

**Loss factor**—The product of the power factor and the dielectric constant.

**Macromolecule**—A molecule of such size that it exhibits colloidal properties.

**Mesocolloids**—Polymers intermediate between hemicolloids and eucolloids; that is, of a degree of polymerization between about 100 and 1000.

**Modulus of elasticity**—The stress required to produce a unit distortion.

**Monomer**—The simplest repeating structural unit of a polymer. For addition polymers this represents the originally unpolymerized compound.

**Natural resins**—Solid substances from vegetable excretions exhibiting brittleness, vitreous luster, conchoidal fracture, water-insolubility and varying fusibility and solubility.

**Novolak**—A permanently fusible and soluble phenol-

aldehyde resin. More specifically it is the reaction-product of 1 molecule of phenol with less than 1 molecule of formaldehyde, and an acid catalyst.

**Organic glass**—A light-colored, transparent synthetic resin or resinous composition designed to simulate or surpass silicate glass in different respects, the ideal resin being expected to exhibit great toughness, light weight, high surface and scratch hardness, low water absorption and solubility, high softening and decomposition points, easy manipulation, and high stability under such conditions as weathering, light, chemical reagents and mechanical shock.

**Phenoplast**—A general term for phenol-aldehyde resins. Synonymous with popular term "phenolics."

**Pitch**—A dark-colored, fusible, more or less viscous to solid bituminous or resinous substance, insoluble in water but more or less soluble in carbon disulfide, benzol, etc. Composition and origin variable.

**Plastic flow**—When the flow is proportional to the pressure in excess of a certain minimum pressure (yield value) necessary to start the flow.

**Plastics**—All substances that can be molded. In general a plastic is a substance which behaves as a solid at stresses less than a certain amount known as the yield value and as a viscous liquid at stresses greater than this. The name is also applied to substances which originally but not ultimately fulfill this condition. For example, it is applied to thermoset compositions or resinoids in the final stages.

**Plasticity**—Susceptibility to and the retention of deformation. Capacity of taking and retaining the form of a mold. The property of solids by virtue of which they hold their shape permanently under the action of small shearing stresses but are readily deformed, worked or molded under larger stresses.

**Polymerization**—A chemical change resulting in the formation of a new compound whose molecular weight is a multiple of that of the original substance. The products of the reaction are called polymers. To distinguish from those resulting from condensation (q.v.), they are often designated addition polymers since the reaction is that of successive addition of a large number of relatively small molecules (monomers) to form the final polymer.

**Positive mold**—A mold designed to trap all the molding material to prevent its escape when it closes.

**Potentially hardening**—A term applied to resinoids, that is, to synthetic resins capable of passing into a C-stage.

**Power factor**—In an insulating material, the ratio of total power loss (watts) in the material to the product of voltage and current in a capacitor in which that material is a dielectric.

**Preforms**—Molding powders converted by pressure and without heat into a denser coherent form which approximates the shape of the final hot-pressed article. Molding material converted to preforms has about half the bulk factor of the original powder. Other forms of densified composition which do not necessarily approximate the shape of the final molding are tablets, briquettes, pellets, pills and balls.

**Resin**—A term generally referring to a physical condition at room temperature approximating the physical properties of natural resins (q.v.). However, the temperature of reference should not be limited to room temperature and the term is here intended to embrace all substances which within a certain temperature range show these properties. For example, many oil-modified alkyd resins are viscous liquids at room temperature but not at lower temperatures; polystyrene is a resin at room temperature but rubber-like when warmed.

**Resinoids**—The class name applied to thermosetting resins. Temporary thermoplastics. The name is also often applied to the final cured resins.

**Resite**—A phenol-aldehyde resin in the C-stage (q.v.).

**Resitol**—A name often applied to a phenol-aldehyde resin in the B-stage (q.v.).

**Resol**—A name often applied to a potentially hardening phenol-aldehyde resin in the A-stage (q.v.).

**Softening point**—Resins have no sharp melting point. Application of heat causes gradual change from a brittle or exceedingly thick and slow flowing material to a softer and less viscous liquid. The softening point is the temperature at which the material flows at a definite rate or to a definite distance.

**Sol**—A colloidal dispersion whose particles have sufficient Brownian motion to keep them in suspension.

**Synlastic**—A synthetic lastic (q.v.). Examples are Thiokol and Neoprene. Another name suggested for substances of this type is collastic.

**Synthetic resin**—A complex, substantially amorphous, organic semi-solid or solid material (usually a mixture of substances) built up by chemical reaction of comparatively simple compounds and, depending upon the temperature at which the examination is made, approximating the natural resins in various physical properties: namely, luster, fracture, comparative brittleness, insolubility in water, fusibility or plasticity when heated or exposed to heat and pressure, and, at a certain more or less narrow temperature range before fusion, showing a degree of rubber-like extensibility; but commonly deviating widely from natural resins in chemical constitution and behavior with reagents.

**Synthetic rubber**—Caoutchouc synthesized in the laboratory. The term is a misnomer and most probably represents an impossibility.

**Tars**—Dark-colored substances, liquid or semi-liquid at room temperature often possessing a characteristic

"tarry" odor, usually insoluble in water but soluble in carbon disulfide, benzol, etc., and which on distillation, oxidation, etc., form a pitch. Composition variable.

**Tensile strength**—The sustained force required to break a piece of unit cross-section.

**Thermoplastic**—The property of softening under heat. All molding materials are thermoplastic at the initial application of heat. One class (the so-called thermoplastics) remains soft permanently under heat; the other (thermosetting), after first softening, sets or cures more or less quickly to a more solid form. A practical distinction is that with the first class the mold must be cooled before the molded article is removed, but not with the second. A thermoplastic substance is adequately rigid at normal temperatures and under ordinary conditions of stress but is capable of deformation under heat and pressure.

**Thermosetting**—The property of undergoing a chemical change when heated whereby a hardened product is obtained. Property most pronounced in phenol- and urea-formaldehyde resins and less so with alkyds. A thermosetting substance possesses initially the properties of a thermoplastic but under the influence of heat undergoes chemical change so that it is no longer thermoplastic but becomes permanently infusible.

**Thixotropy**—The property by which certain compositions become solid when at rest but liquefy again on agitation.

**Transfer molding**—Another name for injection molding (q.v.).

**Treacle stage**—A thermosetting neat resin in liquid form. Particularly applied to casting.

**Urea resins**—Thermosetting light-colored resins from urea and formaldehyde.

**Vinyl resin**—Thermoplastic derivatives of polyvinyl alcohol. Examples are Vinylite and Mowilith.

**Viscosity**—Internal friction or resistance to change of form of a liquid. The constant ratio of shearing stress to rate of shear.

**Water-Absorption**—Amount of water taken up when exposed to humid conditions or when immersed. Both rate of absorption and total absorption are important, also change in dimensions. A certain amount of absorbed water may improve mechanical properties but usually weakens electrical characteristics.

**Yield value**—The lowest pressure at which a plastic will flow. Below this pressure the plastic behaves as an elastic solid; above this pressure as a viscous liquid.

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Beryllium Corp. of Pa., Reading, Pa.  
Gorham Co., Providence, R. I.

### PACKINGS, LEATHER

Graton & Knight Mfg. Co., Worcester, Mass.  
Rhoads & Sons, J. E., Philadelphia, Pa.

### PLATING OF MOLDS, CHROMIUM AND NICKEL

American Nickeloid Corp., Peru, Ill.  
Apollo Metal Works, La Salle, Ill.  
Associated Attleboro Mfrs., Inc., Attleboro, Mass.  
Burr Chromium Co., Inc., Cambridge, Mass.  
Gemloid Corp., New York, N. Y.  
Industrial Plating & Finishing Co., Brooklyn, N. Y.

### PRESSES, ARBOR

American Broach & Machine Co., Ann Arbor, Mich.  
Atlas Press Co., Kalamazoo, Mich.  
Baldwin-Southwark Corp., Philadelphia, Pa.  
Barnes Co., W. F. & John, Rockford, Ill.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Chambersburg Engineering Co., Chambersburg, Pa.  
Elmes Engineering Works, Chas. F., Chicago, Ill.  
French Oil Mill Machinery Co., Piqua, Ohio  
Greenerd Arbor Press Co., Nashua, N. H.  
Hannifin Mfg. Co., Chicago, Ill.  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Lake Erie Engineering Corp., Buffalo, N. Y.  
Logansport Machine Co., Logansport, Ind.  
Watson-Stillman Co., Roselle, N. J.  
Wood Co., R. D., Philadelphia, Pa.

### PRESSES, AUTOMATIC MOLDING

Stokes Machine Co., F. J., Philadelphia, Pa.

### PRESSES, CAKING

Baldwin-Southwark Corp., Philadelphia, Pa.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Burroughs Co., Newark, N. J.  
Cavagnaro, John J., Harrison, N. J.  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Loomis, Everts G., Newark, N. J.  
Watson-Stillman Co., Roselle, N. J.  
Wood Co., R. D., Philadelphia, Pa.

### PRESSES, EMBOSSING

Baldwin-Southwark Corp., Philadelphia, Pa.  
Beck Machine Co., Chas., Philadelphia, Pa.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Bliss Co., E. W., Brooklyn, N. Y.  
Burroughs Engineering Co., Newark, N. J.  
Carver, Fred S., New York, N. Y.  
Cavagnaro, John J., Harrison, N. J.  
Chambersburg Engineering Co., Chambersburg, Pa.  
Dunning & Boschert Press Co., Syracuse, N. Y.  
Elmes Engineering Works, Chas. F., Chicago, Ill.  
Farrel-Birmingham Co., Ansonia, Conn.  
French Oil Mill Machinery Co., Piqua, Ohio  
Grimes & Harris Inc., Leominster, Mass.  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Krehbiel Co., Inc., J. J., New York, N. Y.  
Lake Erie Engineering Corp., Buffalo, N. Y.  
Loomis, Everts, G., Newark, N. J.  
Robertson Co., Inc., John, Brooklyn, N. Y.  
Standard Machinery Co., Mystic, Conn.  
Standard Tool Co., Leominster, Mass.  
Terkelsen Machine Co., Boston, Mass.  
Trand, Alex & Sons, Newark, N. J.  
Watson-Stillman Co., Roselle, N. J.  
Wood Co., R. D., Philadelphia, Pa.

### PRESSES, EXTRUDING

Baldwin-Southwark Corp., Philadelphia, Pa.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Burroughs Engineering Corp., Newark, N. J.  
Carver, Fred S., New York, N. Y.  
Cavagnaro, John J., Harrison, N. J.  
Dunning & Boschert, Syracuse, N. Y.

Elmes Engineering Corp., Chas. F., Chicago, Ill.  
Farrel-Birmingham Co., Ansonia, Conn.  
Farquhar Co., Ltd., A. B., York, Pa.  
French Oil Mill Machinery Co., Piqua, Ohio  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Index Machinery Corp., Cincinnati, Ohio  
Krehbiel Co., Inc., J. J., New York, N. Y.  
Lake Erie Engineering Corp., Buffalo, N. Y.  
Logemann Bros. Co., Milwaukee, Wis.  
Watson-Stillman Co., Roselle, N. J.  
Wood Co., R. D., Philadelphia, Pa.

### PRESSES, HOBBING

Atlas Tool Works, Bridgeport, Conn.  
Baldwin-Southwark Corp., Philadelphia, Pa.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Burroughs Engineering Co., Newark, N. J.  
Elmes Engineering Works, Chas. F., Chicago, Ill.  
French Oil Mill Machinery Co., Piqua, Ohio  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Kleckley Co., O. C., Chicago, Ill.  
Lake Erie Engineering Corp., Buffalo, N. Y.  
Newark Die Co., Newark, N. J.  
Robertson Co., Inc., John, Brooklyn, N. Y.  
Watson-Stillman Co., Roselle, N. J.  
Wood Co., R. D., Philadelphia, Pa.

### PRESSES, HYDRAULIC

Baldwin-Southwark Corp., Philadelphia, Pa.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Burroughs Engineering Co., Newark, N. J.  
Carver, Fred S., New York, N. Y.  
Dunning & Boschert Press Co., Syracuse, N. Y.  
Elmes Engineering Works, Chas. F., Chicago, Ill.  
Farquhar Co., Ltd., A. B., York, Pa.  
Farrel-Birmingham Co., Inc., Ansonia, Conn.  
French Oil Mill Machinery Co., Piqua, Ohio  
Greenerd Arbor Press Co., Nashua, N. H.  
Hannifin Mfg. Co., Chicago, Ill.  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Index Machinery Corp., Cincinnati, Ohio  
Lake Erie Engineering Corp., Buffalo, N. Y.  
Logemann Bros. Co., Milwaukee, Wis.  
Loomis, Everts G., Newark, N. J.  
National Erie Co., Erie, Pa.  
Spadone Machine Co., Inc., New York, N. Y.  
Standard Machinery Co., Mystic, Conn.  
Terkelsen Machine Co., Boston, Mass.  
Watson-Stillman Co., Roselle, N. J.  
Wood Co., R. D., Philadelphia, Pa.

### PRESSES, INJECTION MOLDING

Baldwin-Southwark Corp., Philadelphia, Pa.  
Burroughs Engineering Co., Newark, N. J.  
De Mattia Machinery & Tool Works, Clifton, N. J.  
Grotelite Co., Bellevue, Ky.  
Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
Index Machinery Corp., Cincinnati, Ohio  
Krehbiel Co., Inc., J. J., New York, N. Y.  
Lester Engineering Co., Cleveland, Ohio  
Reed-Prentice Corp., Worcester, Mass.

### PRESSES, INLAYING

Ams Machine Co., Max, Bridgeport, Conn.  
Baldwin-Southwark Corp., Philadelphia, Pa.  
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
Bliss Co., E. W., Brooklyn, N. Y.  
Cameron Can Machinery Co., Chicago, Ill.  
Carver, Fred S., New York, N. Y.  
French Oil Mill Machinery Co., Piqua, Ohio

Grimes & Harris, Inc., Leominster, Mass.  
 Henry & Wright Mfg. Co., Hartford, Conn.  
 Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
 Index Machinery Corp., Cincinnati, Ohio  
 Loomis, Everts G., Newark, N. J.  
 Niagara Machine & Tool Works, Buffalo, N. Y.  
 Peck-Stow & Wilcox Co., Southington, Conn.  
 Standard Machinery Co., Mystic, Conn.  
 Standard Tool Co., Leominster, Mass.  
 Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.  
 Watson-Stillman Co., Roselle, N. J.

#### PRESSES, LABORATORY

Adamson Machine Co., Akron, Ohio  
 Baldwin-Southwark Corp., Philadelphia, Pa.  
 Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
 Burroughs Engineering Co., Newark, N. J.  
 Carver, Fred S., New York, N. Y.  
 Cavagnaro, John J., Harrison, N. J.  
 Colton Co., Arthur, Detroit, Mich.  
 Elmer & Amend, New York, N. Y.  
 Elmes Engineering Works, Chas. F., Chicago, Ill.  
 Farrel-Birmingham Co., Ansonia, Conn.  
 French Oil Mill Machinery Co., Piqua, Ohio  
 Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
 Index Machinery Corp., Cincinnati, Ohio  
 Krehbiel Co., Inc., J. J., New York, N. Y.  
 Kux-Lohner Machine Co., Chicago, Ill.  
 Lake Erie Engineering Corp., Buffalo, N. Y.  
 Loomis, Everts G., Newark, N. J.  
 Patterson Foundry & Machine Co., E., Liverpool, Ohio  
 Stokes Machine Co., F. J., Philadelphia, Pa.  
 Terkelsen Machine Co., Boston, Mass.  
 Watson-Stillman Co., Roselle, N. J.  
 Wood Co., R. D., Philadelphia, Pa.

#### PRESSES, PERFORMING

Colton Company, Arthur, Detroit, Mich.  
 Elmes Engineering Works, Chas. F., Chicago, Ill.  
 Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
 Kux-Lohner Machine Co., Chicago, Ill.  
 Loomis, Everts G., Newark, N. J.  
 Stokes Machine Co., F. J., Philadelphia, Pa.  
 Watson-Stillman Co., Roselle, N. J.

#### PRESSES, TOGGLE

Ams Machine Co., Max, Bridgeport, Conn.  
 Bliss Co., E. W., Brooklyn, N. Y.

Dunning & Boschert Press Co., Syracuse, N. Y.  
 Engineering Laboratories, Inc., R. F. D. 1, Paterson, N. J.  
 Hannifin Mfg. Co., Chicago, Ill.  
 Index Machinery Corp., Cincinnati, Ohio  
 Krehbiel Co., Inc., J. J., New York, N. Y.  
 Lake Erie Engineering Corp., Buffalo, N. Y.  
 Logemann Bros. Co., Milwaukee, Wis.  
 Niagara Machine & Tool Works, Buffalo, N. Y.  
 Standard Machinery Co., Mystic, Conn.  
 Standard Tool Co., Leominster, Mass.  
 Terkelsen Machine Co., Boston, Mass.  
 Toledo Machine & Tool Co., Toledo, Ohio  
 Waterbury-Farrel Foundry & Machine Co., Mystic, Conn.

#### PUMPS, HYDRAULIC

Aldrich Pump Co., Allentown, Pa.  
 American Engineering Co., Philadelphia, Pa.  
 American Steam Pump Co., Battle Creek, Mich.  
 American Well Works, Aurora, Ill.  
 Baldwin-Southwark Corp., Philadelphia, Pa.  
 Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.  
 Brown & Sharpe Mfg. Co., Providence, R. I.  
 Burroughs Engineering Co., Newark, N. J.  
 Carbondale Machine Co., Carbondale, Pa.  
 Chambersburg Engineering Co., Chambersburg, Pa.  
 De Laval Steam Turbine Co., Trenton, N. J.  
 Dunning & Boschert Press Co., Syracuse, N. Y.  
 Elmes Engineering Works, Chas. F., Chicago, Ill.  
 Erie Pump & Engine Works, Medina, N. Y.  
 Farquhar Co., Ltd., A. B., York, Pa.  
 French Oil Mill Machinery Co., Piqua, Ohio  
 Hydraulic Engineering Works, Chicago, Ill.  
 Hydraulic Press Mfg. Co., Mount Gilead, Ohio  
 Ingersoll Rand Co., New York, N. Y.  
 Lake Erie Engineering Corp., Buffalo, N. Y.  
 Logemann Bros. Co., Milwaukee, Wis.  
 Loomis, Everts G., Newark, N. J.  
 Pennsylvania Pump & Compressor Co., Easton, Pa.  
 Robertson Co., Inc., John, Brooklyn, N. Y.  
 Union Steam Pump Co., Battle Creek, Mich.  
 Vickers Inc., Detroit, Mich.  
 Watson-Stillman Co., Roselle, N. J.  
 Wood Co., R. D., Philadelphia, Pa.  
 Worthington Pump & Machinery Corp., Harrison, N. J.

#### PUMPS, VACUUM

Aldrich Pump Co., Allentown, Pa.  
 Beechus Co., Chicago, Ill.  
 Kinney Mfg. Co., Boston, Mass.  
 Lammert & Mann Co., Chicago, Ill.  
 Loomis, Everts G., Newark, N. J.  
 National Scientific Corp., Chicago, Ill.  
 Pennsylvania Pump & Compressor Co., Easton, Pa.  
 Stokes Machine Co., F. J., Philadelphia, Pa.  
 Worthington Pump & Machinery Corp., Harrison, N. J.

#### PYROMETERS

Bailey Meter Co., Cleveland, Ohio  
 Briston Co., Waterbury, Conn.  
 Brown Instrument Co., Philadelphia, Pa.  
 Cambridge Instrument Co., Inc., New York, N. Y.  
 Engelhard, Inc., Chas., Newark, N. J.  
 Hoskins Mfg. Co., Detroit, Mich.  
 Illinois Testing Laboratories, Inc., Chicago, Ill.  
 Index Machinery Corp., Cincinnati, Ohio  
 Leeds & Northrup Co., Philadelphia, Pa.  
 Pyrometer Instrument Co., New York, N. Y.  
 Republic Flow Meters Co., Chicago, Ill.  
 Russell Electric Co., Chicago, Ill.  
 Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.  
 Taylor Instrument Co., Rochester, N. Y.  
 Wilson-Maculen Pyrometer Co., Foxboro, Mass.

#### SCREWS—HARDENED SELF-TAPPING FOR PLASTIC PRODUCTS

Parker-Kalon Corp., New York, N. Y.  
 Shakeproof Lock Washer Co., Chicago, Ill.

#### TESTING APPARATUS

Scott, Henry L. & Co., Providence, R. I.  
 Shallcross Mfg. Co., Collingdale, Pa.  
 Tinius Olsen Testing Machine Co., Philadelphia, Pa.

#### TOOL STEEL FOR HOBBED MOLDS, FOR MACHINED MOLDS, FOR HOBS

American Rolling Mill, Middletown, Ohio  
 Carpenter Steel Co., Reading, Pa.  
 Crucible Steel Co. of America, New York, N. Y.  
 Jessop & Sons, Inc., Wm., New York, N. Y.  
 La Trobe Elec. Steel Co., La Trobe, Pa.  
 Ludlum Steel Co., Watervliet, N. Y.  
 McDonald & Co., P. F., Boston, Mass.  
 Republic Steel Corp., Cleveland, Ohio  
 Vanadium Alloy Steel Co., Latrobe, Pa.  
 Ziv Steel and Wire Co., Chicago, Ill.

## DIRECTORY OF CUSTOM MOLDERS, FABRICATORS, DESIGNERS

AND OTHER SERVICES ESSENTIAL TO THE PRODUCTION OF FINISHED ARTICLES OF PLASTIC COMPOSITION MATERIALS

#### CUSTOM MOLDERS

Accurate Molding Corp., Brooklyn, N. Y.  
 Alden Products Co., Brockton, Mass.  
 American Insulator Corp., New Freedom, Pa.  
 Armstrong Cork Products Co., Closure

Division, Lancaster, Pa.  
 Associated Attleboro Mfrs., Inc., Attleboro, Mass.  
 Auburn Button Works, Inc., Auburn, N. Y.  
 Automatic Molded Prods. Co., Long Island City, N. Y.  
 Bay State Molding Co., Boston, Mass.

Berkander, Geo. F., Providence, R. I.  
 Boonton Molding Co., Boonton, N. J.  
 Breeze Corp., Newark, N. J.  
 Bridgeport Molded Products, Inc., Bridgeport, Conn.  
 Bryant Electric Co., Hemco Plastics Division, Bridgeport, Conn.

Butterfield Inc., T. F., Naugatuck, Conn.  
 Carbide & Carbon Chemicals Corp., New York, N. Y.  
 Celluloid Corp., New York, N. Y.  
 Chicago Molded Products Corp., Chicago, Ill.  
 Cincinnati Molding Co., Cincinnati, Ohio  
 Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.  
 Consolidated Molded Products Corp., Scranton, Pa.  
 Cutler-Hammer, Inc., Milwaukee, Wis.  
 Davies Company, Harry, Chicago, Ill.  
 Dayton Insulating Molding Co., Dayton, Ohio  
 Diemolding Corp., Canastota, N. Y.  
 Eclipse Moulded Products Co., Milwaukee, Wis.  
 Economy Fuse & Mfg. Co., Chicago, Ill.  
 Erie Resistor Corp., Erie, Pa.  
 General Electric Co., Plastics Dept., Pittsfield, Mass.  
 General Industries Co., Elyria, Ohio  
 General Insulate Co., Inc., Brooklyn, N. Y.  
 General Molding Co., Philadelphia, Pa.  
 General Products Corp., Union Springs, N. Y.  
 Gits Corp., Chicago, Ill.  
 Gorham Company, Plastics Division, Providence, R. I.  
 Grigoleit Co., Decatur, Ill.  
 Hahn Mfg. Co., Harry W., Los Angeles, Calif.  
 Hurst Inc., Boston, Mass.  
 Hyde, A. L., Grenloch, N. J.  
 Imperial Molded Products Corp., Chicago, Ill.  
 Insulation Mfg. Co., Inc., Brooklyn, N. Y.  
 Kellogg Switchboard & Supply Co., Chicago, Ill.  
 Keystone Specialty Co., Cleveland, Ohio  
 Kuhn & Jacob Moulding & Tool Co., Trenton, N. J.  
 Kurz-Kasch, Inc., Dayton, Ohio  
 Lapin-Kurley Kew, Inc., New York, N. Y.  
 Liberty Molding Works, Attleboro, Mass.  
 Los Angeles Molding Co., Los Angeles, Calif.  
 Mack Molding Co., Inc., Wayne, N. J.  
 Midwest Molding & Mfg. Co., Chicago, Ill.  
 Molded Insulation Co., Philadelphia, Pa.  
 Molding Corp. of America, Providence, R. I.  
 Moldite Corp., New York, N. Y.  
 Niagara Insul-Bake Specialty Co., Inc., Albany, N. Y.  
 Northern Industrial Chemical Co., Boston, Mass.  
 Norton Laboratories, Inc., Lockport, N. Y.  
 Oris Mfg. Co., Thomaston, Conn.  
 O'Shei, B. F., Buffalo, N. Y.  
 Owens-Illinois Glass Co., Closure Div., Toledo, Ohio  
 Plano Molding Co., Plano, Ill.  
 Plastic Molding Corp., Sandy Hook, Conn.  
 Plastic Molding Corp., Cincinnati, Ohio  
 Plastic Molding Corp., Newark, N. J.  
 Recto Molded Products, Inc., Cincinnati, Ohio  
 Remler Co., Ltd., San Francisco, Calif.  
 Reynolds Spring Co., Molded Plastics Division, Jackson, Mich.  
 Richardson Company, Melrose Park (Chicago), Ill.  
 Royal Molding Co., Providence, R. I.  
 Seamless Rubber Co., New Haven, Conn.  
 Shaw Insulator Co., Irvington, N. J.  
 Siemon Company, Bridgeport, Conn.  
 Specialty Insulation Co., Hoosick Falls, N. Y.  
 Stokes Rubber Co., Jos., Trenton, N. J.  
 Synthetic Moulded Products, Inc., Stonington, Conn.  
 Tech-Art Plastics Co., Long Island City, N. Y.  
 Torkelsen Machine Co., Boston, Mass.  
 Union Insulating Co., Parkersburg, W. Va.  
 Universal Molding Co., San Francisco, Calif.

Universal Plastics Corp., New Brunswick, N. J.  
 Voges Mfg. Co., Ozone Park, Long Island, N. Y.  
 Ward Plastic & Rubber Co., Detroit, Mich.  
 Waterbury Button Co., Waterbury, Conn.  
 Watertown Mfg. Co., Watertown, Conn.  
 Wheeling Stamping Co., Wheeling, W. Va.

## INJECTION MOLDERS, CUSTOM

Allen Industries, Inc., Detroit, Mich.  
 American Insulator Corp., New Freedom, Pa.  
 Belmont Molded Plastics, Inc., Cincinnati, Ohio  
 Berkander, George F., Providence, R. I.  
 Boonton Molding Co., Boonton, N. J.  
 Bridgeport Molded Products, Inc., Bridgeport, Conn.  
 Butterfield, Inc., T. F., Naugatuck, Conn.  
 Celluloid Corp., Newark, N. J.  
 Chicago Molded Products Corp., Chicago, Ill.  
 Commonwealth Plastics Co., Leominster, Mass.  
 Consolidated Molded Products Corp., Scranton, Pa.  
 Detroit Macoid Co., Detroit, Mich.  
 Erie Resistor Corp., Erie, Pa.  
 Emeloid Co., Inc., The, Arlington, N. J.  
 General Electric Co., Plastics Dept., Pittsfield, Mass.  
 General Industries Co., Elyria, Ohio  
 Gits Corp., Chicago, Ill.  
 Hahn Mfg. Co., Harry W., Los Angeles, Calif.  
 Hyde, A. L., Grenloch, N. J.  
 Kingman Company, E. B. Leominster, Mass.  
 Mack Molding Co., Wayne, N. J.  
 Mason, Thomas & Co., New York, N. Y.  
 Mills Co., Elmer E., Chicago, Ill.  
 Norton Laboratories, Inc., Lockport, N. Y.  
 Reynolds Spring Co., Molded Plastics Division, Jackson, Mich.  
 Salz Bros., New York, N. Y.  
 Seamless Rubber Co., New Haven, Conn.  
 Stokes Rubber Co., Jos., Trenton, N. J.  
 Thermo-Plastics, Inc., St. Claire, Mich.  
 Tilton-Cook Co., Leominster, Mass.  
 Watertown Mfg. Co., Watertown, Conn.

## DENTURE MATERIALS

Bakelite Dental Prods., Inc., New York, N. Y.  
 Fiberloid Corp., Indian Orchard, Mass.

## DESIGNERS, INDUSTRIAL

Ackerman, Jay, 235 East 22 St., N. Y. C.  
 Adams, Wilbur Henry, 2341 Carnegie Ave., Cleveland, Ohio  
 Arens, Egmont, 480 Lexington Ave., N. Y. C.  
 Aronson, Joseph, 215 East 58 St., N. Y. C.  
 Bach, Alphonse, 724 Fifth Ave., N. Y. C.  
 Bach, Oscar, 305 East 46 St., N. Y. C.  
 Barnes & Reinecke, 664 No. Michigan Ave., Chicago, Ill.  
 Bel Geddes, Norman, 28 East 37 St., N. Y. C.  
 Bernhard, Lucian, 120 East 86 St., N. Y. C.  
 Blow, George; De Vaultier and Blow, 103 Park Ave., N. Y. C.  
 Bureau, Achille G., 374 Burns St., Forest Hills, N. Y.  
 Castaing, C. K., Stony Brook, L. I.  
 Cheron, Pierre, 65 Locust St., Stratford, Conn.  
 Conant, Roger, 320 East 53 St., N. Y. C.  
 Deskey, Donald, 630 Fifth Ave., N. Y. C.  
 De Vaultier, Simon; De Vaultier and Blow, 103 Park Ave., N. Y. C.  
 De Vries, Herman, 49 W. 45 St., N. Y. C.

Dreyfuss, Henry, 501 Madison Ave., N. Y. C.  
 Dryden, Helen, 25 Fifth Ave., N. Y. C.  
 Dulany, Helen Hughes, 936 Lake Shore Drive, Chicago, Ill.  
 Erwin, Hobe G., 15 East 57 St., N. Y. C.  
 Farr, Fred, 311 Prospect Ave., Mamaronck, N. Y.  
 Federico, Jos. B., Portage Rd., Niagara Falls, N. Y.  
 French, Carroll, 216 E. 15 St., N. Y. C.  
 Gaba, Lester, 347 Fifth Ave., N. Y. C.  
 Gates, John M., 748 Fifth Ave., N. Y. C.  
 Gerth, Ruth K., 132 E. 58 St., N. Y. C.  
 Gerth, William, 1625 Second Ave., N. Y. C.  
 Guild, Lurette, 522 Fifth Ave., N. Y. C.  
 Hall, Frances Cushing, 24 Fifth Ave., N. Y. C.  
 Hamil, Virginia, 6 East 45 St., N. Y. C.  
 Heller, Robert Inc., 515 Madison Ave., N. Y. C.  
 Hornung, Clarence P., 23 West 47 St., N. Y. C.  
 Jackson, Edwin, 175 East 60 St., N. Y. C.  
 Jensen, Gustav, 288 Lexington Ave., N. Y. C.  
 Jiranek, Leo, 30 Rockefeller Plaza, N. Y. C.  
 Ketcham, Howard, 30 Rockefeller Plaza, N. Y. C.  
 Kiesler, Frederic, 56 Seventh Ave., N. Y. C.  
 Kogan, Belle, 185 Madison Ave., N. Y. C.  
 Kropp, Willis Ahlborn, Oak Park, Ill.  
 Lescaze, William, 211 E. 48 St., N. Y. C.  
 Linder, Laura Lee, Pittsfield, Mass.  
 Little, John, 101 Park Ave., N. Y. C.  
 Loewy, Raymond, 580 Fifth Ave., N. Y. C.  
 Lux, Eugene, 44 W. 56 St., N. Y. C.  
 MacAlister, Paul, 30 Rockefeller Plaza, N. Y. C.  
 Mandel, Earl, 211 Van Buren Ave., Teaneck, N. J.  
 Miller, Frances T., 24 W. 55 St., N. Y. C.  
 Muller, Theodore Carl, 30 Rockefeller Plaza, N. Y. C.  
 Mulier-Munk, Peter, Carnegie Tech, Pittsburgh, Pa.  
 Nash, Ben, 30 Rockefeller Plaza, N. Y. C.  
 Parzinger, Tommi, 320 E. 57 St., N. Y. C.  
 Patmore, Derek, 146a E. 55 St., N. Y. C.  
 Petrucelli, Antonio, 30 E. 20 St., N. Y. C.  
 Preis, Marion, 177 E. 87 St., N. Y. C.  
 Reeves, Ruth, 84 University Place, N. Y. C.  
 Rensinger, Paul, Chicago, Ill.  
 Rideout, Jack, 520 Caxton Bldg., Cleveland, Ohio  
 Rohde, Gilbert, 32 E. 57 St., N. Y. C.  
 Root, John, 3728 Lowell Ave., Chicago, Ill.  
 Sakier, George, 40 W. 40 St., N. Y. C.  
 Sanders, Morris B., 219 E. 49 St., N. Y. C.  
 Saymon, Clarice Inc., 9 Rockefeller Plaza, N. Y. C.  
 Scheele, Edwin H., 419 Fourth Ave., N. Y. C.  
 Simonson, Lee, 217 E. 48 St., N. Y. C.  
 Slobodkin, Simon, 39 E. 23 St., N. Y. C.  
 Streng, Jan, 66 Fifth Ave., N. Y. C.  
 Sundberg & Ferar, 207 Stephenson Bldg., Detroit, Mich.  
 Swibold, Duane, 40 W. Milwaukee, Detroit, Mich.  
 Switzer, George, 336 Central Park W., N. Y. C.  
 Szabo, Bela, 607 W. 43 St., N. Y. C.  
 Teague, Walter Dorwin, 210 Madison Ave., N. Y. C.  
 Teegan, Otto, 5 East 57 St., N. Y. C.  
 Thelander, Clement J., 646 No. Michigan Ave., Chicago, Ill.  
 Tibbs, Thomas, 38 Gramercy Pk. E., N. Y. C.  
 Van Doren, Harold, 1217 Madison Ave., Toledo, Ohio  
 Vassos, John, Comstock Hill, Norwalk, Conn.  
 Versen, Kurt, 373 Fourth Ave., N. Y. C.  
 Von Nessen, Walter, 211 E. 49 St., N. Y. C.  
 Weill, Paul, Inc., 40 E. 49th St., N. Y. C.  
 Wieselthier, Vally, 301 East 38 St., N. Y. C.  
 Wilson, Scott, 342 Madison Ave., N. Y. C.  
 Wright, Russel, 130 East 40 St., N. Y. C.

# MOLDERS' MARKINGS



Accurate Molding Co.,  
Brooklyn, N. Y.

AMCO

Accurate Molding Co.,  
Brooklyn, N. Y.



The Ackerman Rubber &  
Plastic Molding Company,  
Cleveland, Ohio



Alden Products Corp.,  
Brockton, Mass.



American Hard Rubber Co.,  
Butler, N. J.



American Insulator Corp.,  
New Freedom, Pa.



The Arrow-Hart & Hegeman  
Electric Co., Hartford, Conn.



Associated Attleboro Mfrs.,  
Inc., Attleboro, Mass.



Auburn Button Works,  
Auburn, N. Y.

Berkalin  
QUALITY  
JEWELRY

MADE IN U.S.A.

Geo. F. Berkander,  
Providence, R. I.



Beeton Molding Co.,  
Beeton, N. J.



Bridgeport Moulded  
Products, Inc.,  
Bridgeport, Conn.



Bryant Electric Co.,  
Bridgeport, Conn.



Chicago Molded Products  
Corp., Chicago, Ill.



Cincinnati Molding Co.,  
Cincinnati, Ohio



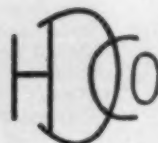
Colt's Patent Fire Arms Co.,  
Hartford, Conn.



Consolidated Molded  
Products Corp., Scranton, Pa.



Cutler-Hammer, Inc.,  
Milwaukee, Wisconsin



Harry Davis Company, Inc., Chicago, Ill.

DAKA-WARE



Diemolding Corp.,  
Canastota, N. Y.

"tec"

The Emeloid Co., Inc.,  
Arlington, N. J.



Garfield Mfg. Co.,  
Garfield, N. J.



General Electric Co.,  
Pittsfield, Mass.



General Industries Inc.,  
Elyria, Ohio



The Grigoleit Co.,  
Decatur, Ill.



Wm. Gulliksen Machinery  
Co., Newton Lower Falls,  
Mass.



Harry W. Hahn Mfg. Co.,  
Los Angeles, Calif.



Imperial Molded Products  
Co., Chicago, Ill.



Keesbey & Mattison Co.,  
Ambler, Pa.



Kellogg Switchboard and  
Supply Co., Chicago, Ill.



Kuhn and Jacob Moulding  
& Tool Co., Trenton, N. J.



Kurz-Kasch, Inc.,  
Dayton, Ohio



Mack Molding Co., Inc.,  
Wayne, N. J.



McDonald Mfg. Co.,  
Los Angeles, Calif.



Midwest Molding & Mfg. Co.,  
Chicago, Ill.



Molded Insulation Co.,  
Philadelphia, Pa.



Molding Corp. of America,  
Providence, R. I.



Moto-Meter Gauge and  
Equip. Co., Toledo, Ohio



Nagel Electric Co.,  
Cincinnati, Ohio



Northern Industrial Chemical  
Co., S. Boston, Mass.



Bell Mfg. Co., Division of  
Northern Industrial Chemical  
Co., S. Boston, Mass.



Norton Laboratories,  
Lockport, N. Y.



Orit Mfg. Co.,  
Thomaston, Conn.



The Panelyte Corp.,  
New York, N. Y.



Plastic Molding Corp.,  
Cincinnati, Ohio



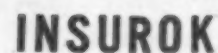
Recto Molded Products Co.,  
Cincinnati, O.



Reynolds Spring Co.,  
Jackson, Mich.



Reynolds Spring Co.,  
Jackson, Mich.



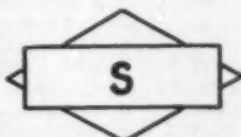
The Richardson Co.,  
Melrose Park, Chicago, Ill.



Royal Molding Co.,  
Providence, R. I.



Shaw Insulator Co.,  
Irvington, N. J.



Shaw Insulator Co.,  
Irvington, N. J.



Specialty Insulation Mfg. Co.,  
Inc., Hoosick Falls, N. Y.



Jos. Stokes Rubber Co.,  
Trenton, N. J.



Synthetic Molded Products,  
Inc., Stonington, Conn.



Tech-Art Plastics Co.,  
Long Island City, N. Y.



Terhelsen Machine Co.,  
Boston, Mass.



Union Insulating Co.,  
Parkersburg, W. Va.



Universal Molding Co.,  
San Francisco, Calif.



Universal Plastics Corp.,  
New Brunswick, N. J.



Waterbury Button Co.,  
Waterbury, Conn.



Watertown Mfg. Co.,  
Watertown, Conn.



Westinghouse Elec. & Mfg.  
Co., E. Pittsburgh, Pa.



Wheeling Stamping Co.,  
Wheeling, W. Va.

## FABRICATORS, CASEIN

Aladdin Corp., Orange, N. J.  
American Plastics Corp., N. Y. C.  
Baff Mfg. Co., No. Arlington, N. J.  
Elite Jewelry Prod. Inc., N. Y. C.  
Morrell, Geo., Muskegon, Mich.  
Voges Mfg. Co., Ozone Park, N. Y.

## FABRICATORS, CAST RESIN

Ace Plastic Novelty Corp., Brooklyn, N. Y.  
Apex Specialties Corp., Brooklyn, N. Y.  
Baff Mfg. Co., No. Arlington, N. J.  
Bauring Corp., Long Island City, N. Y.  
Berkander, Geo. F., Providence, R. I.  
Casca Products Corp., Bridgeport, Conn.  
Chicago Button & Buckle Co., Chicago, Ill.  
Colonial Kolonite Co., Chicago, Ill.  
Commonwealth Plastics Co., Leominster, Mass.  
Crest Mfg. Co., N. Y. C.  
Ditglo Mfg. Co., Inc., New York, N. Y.  
Expert Celluloid Co., Inc., Long Island City, N. Y.  
Fiberloid Corp., Indian Orchard, Mass.  
Foster Grant Co., Inc., Leominster, Mass.  
Gaess & Hollander, Astoria, Long Island, N. Y.  
Goro Mfg. Co., New York, N. Y.  
Hurst, Inc., Boston, Mass.  
Industrial Plastics Co., New York, N. Y.  
Ivory Craft Co., Long Island City, N. Y.  
Keolyn Plastics Co., Chicago, Ill.  
King Mfg. Co., J. M., Philadelphia, Pa.  
Kingman Co., E. B., Leominster, Mass.  
Kirk Mfg. Co., Los Angeles, Calif.  
Krest Mfg. Co., New York, N. Y.  
Kreul Co., H., Detroit, Mich.  
Lapin-Kurley Kew, Inc., New York, N. Y.  
Lippincott, Geo. A., Philadelphia, Pa.  
Marbelite Co., Wallingford, Conn.  
Martin Art Co., Chicago, Ill.  
Millers Falls Co., Greenfield, Mass.  
Modern Plastics Sales Co., Philadelphia, Pa.  
National Lock Co., Rockford, Ill.  
Neomode Co., Lancaster, Pa.  
New England Novelty Co., Leominster, Mass.  
Ortho Plastic Co., New York, N. Y.  
Philwin-Shaff, Inc., New York, N. Y.  
Plastic Specialties, Inc., Brooklyn, N. Y.  
Plastic Turning Co., Leominster, Mass.  
Ply-Tex Mfg. Co., Brooklyn, N. Y.  
Quality Turning Co., Leominster, Mass.  
Rex Products Corp., New York, N. Y.  
Roberts Mfg. Co., Providence, R. I.  
Rogers Mfg. Co., Rockfall, Conn.  
Scafer Brass & Mfg. Co., St. Louis, Mo.  
Seeburger, Fred B., Philadelphia, Pa.  
Sohn Mfg. Co., T. M., Fremont, Ohio  
Speidel Chain Corp., Providence, R. I.  
Standard Rubber Co., New York, N. Y.  
Sturdy Bros., Chartley, Mass.  
Thermo-Plastic Laboratories, Inc., Wilkes-Barre, Pa.  
Thomas Mfg. Co., Providence, R. I.  
Turner Device, Inc., St. Louis, Mo.  
Turner, Douglas, St. Louis, Mo.  
Tyson, J. H., Wilkes-Barre, Pa.  
Uncas Mfg. Co., Providence, R. I.  
United Comb & Novelty Co., Leominster, Mass.  
Voges Mfg. Co., Ozone Park, Long Island, N. Y.  
Weil, Edgar, Philadelphia, Pa.

## FABRICATORS, PYROXYLIN

Astorloid Mfg. Co., Inc., Brooklyn, N. Y.  
Bachman Bros., Inc., Philadelphia, Pa.  
Baff Mfg. Co., No. Arlington, N. J.  
Banthico, Inc., Chicago, Ill.  
Berkander, Geo. F., Providence, R. I.  
Camillus Cutlery Co., New York, N. Y.  
Celluloid Corp., New York, N. Y.  
Commonwealth Plastics Co., Leominster, Mass.

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Elite Jewelry Prod., Inc., New York, N. Y.  
Elkoid Co., Providence, R. I.  
Emeloid Co., Inc., Arlington, N. J.  
Felsenthal & Sons, G., Chicago, Ill.  
Fiberloid Corp., Indian Orchard, Mass.  
Foster Grant Co., Inc., Leominster, Mass.  
Gemloid Corp., New York, N. Y.  
Gruver Mfg. Co., Chicago, Ill.  
Hopp Press, Inc., New York, N. Y.  
Johnson Fare Box Co., Chicago, Ill.  
Kingman Co., E. B., Leominster, Mass.  
Kippy Kit Co., Circleville, Ohio  
Landers, Frary & Clark, New Britain, Conn.  
Markilo Co., Chicago, Ill.  
Mason & Company, Newark, N. J.  
New Haven Clock Co., New Haven, Conn.  
Nixon Nitration Works, Nixon, N. J.  
Parisian Novelty Corp., Chicago, Ill.  
Plastic Turning Co., Leominster, Mass.  
Quality Turning Co., Leominster, Mass.  
Rebel & Frank, Inc., Cleveland, Ohio  
Rex Products Corp., New York, N. Y.  
Salz Bros., Inc., New York, N. Y.  
Silverloid Co., Providence, R. I.  
Tilton-Cook Co., Leominster, Mass.  
Van Aram Mfg. Co., Fort Wayne, Ind.  
Wallstein Industrial Corp., Brooklyn, N. Y.  
Williams & Marcus Co., Philadelphia, Pa.

## FABRICATORS, PYROXYLIN COATING

Athol Manufacturing Co., New York, N. Y.  
Boston Woven Hose and Rubber Co., Boston, Mass.  
Bowen Mills, Inc., Pawtucket, R. I.  
Carpenter & Co., L. E., Newark, N. J.  
Chase & Co., L. C., New York, N. Y.  
Coated Textile Mills Inc., Providence, R. I.  
Columbus Coated Fabrics Co., Columbus, Ohio  
Cotex Corp., Newark, N. J.  
Davis, Kraus & Miller, Detroit, Mich.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Federal Leather Co., Belleville, N. J.  
Holliston Mills, The, New York, N. Y.  
Interlaken Mills, New York, N. Y.  
Keratol Co., The, Newark, N. J.  
Landers Corp., Toledo, Ohio  
Masland Duralather Co., New York, N. Y.  
Pantasole Leather Co., Passaic, N. J.  
Permatex Fabric Co., Jewett City, Conn.  
Permatex Fabrics Co., The, New York, N. Y.  
St. Clair Rubber Co., Detroit, Mich.  
Standard Textile Prods. Co., New York, N. Y.  
Textileather Corp., New York, N. Y.  
Western Shade Cloth Products, Inc., Chicago, Ill.  
Weymouth Art Leather Co., East Weymouth, Mass.  
Zapon Co., The, New York, N. Y.

## FABRICATORS, VINYL

Carbide and Carbon Chemicals Corp., Vinylite Div., New York, N. Y.

## LAMINATORS

Atlas Powder Co., Zapon Div., Stamford, Conn.  
Revolite for diaphragms, packings, etc.  
Brown-Freeman Corp., Garwood, N. J.  
Finished panels for furniture, wall paneling and partitions.  
Continental-Diamond Fibre Co., Newark, Del.  
Sheets, rods, tubes and special shapes; rail joint insulation; refrigerator breaker strips; panels in natural wood grain

finishes and marble effects; electrical insulation; fabricated fibre parts; silent gears.

Detroit Paper Products Corp., Detroit, Mich.

Breaker strips, trim strips, corner pieces.  
Formica Insulation Company, Cincinnati, Ohio

Sheets, rods, tubes and fabricated parts; refrigerator breaker strips; decorative panels; gear blanks and gears, etc.

Franklin-Fibre-Lamitex Corp., No. Wilmington, Del.

Sheets, rods, tubes and fabricated parts.  
General Electric Co., Plastics Dept., Pittsfield, Mass.

Textolite laminated sheets, rods, tubes and special forms.

General Laminated Products, Inc., New York, N. Y., and Chicago, Ill.

Fabricators of General Electric Textolite Laminated.

Masonite Corp., Laurel, Miss.

Manufacture Benalite and Benaloid.

Mica Insulator Co., New York, N. Y.

Laminated sheets, tubes, rods and fabricated parts. Decorative sheets, translucent sheets, gear stock.

Micarta Fabricators of Illinois, Chicago, Ill.

National Vulcanized Fibre Co., Wilmington, Del.

Standard forms of sheets, tubes and rods; machine stamped and fabricated shapes, such as panels, washers, bushings, etc.

Panelite Corp., New York, N. Y.

Sheets, rods, tubes, breaker strips, electrical insulation, molded shapes, fabricated and punched parts, gear blanks.

Richardson Co., Melrose Park (Chicago), Ill.

Sheets, rods, tubes, gear blanks, bearings, bushings, washers, panels; special parts; punched and fabricated breaker strips, etc.

Spaulding Fibre Co., Inc., Tonawanda, N. Y.

Synthane Corp., Oaks, Pa.

Laminated products; sheets, rods, tubes, fabricated parts; bushings; gears; deals; insulation; screw machine parts; stabilized material.

Taylor Fibre Co., Norristown, Pa.

Phenol Fibre sheets, rods, tubes and machined parts; Phenol Fabric laminated Bakelite and laminated Phenol Fibre sheets, rods, tubes, machined parts and gear blanks.

Westinghouse Electric & Mfg. Co., Micarta Division, Trafford, Pa.

Sheets, rods, tubes and fabricated parts; refrigerator breaker strips; decorative sheets, panels, base board, etc.; gear plate, gear blanks, laminated molded parts.

Wilmington Fibre & Specialty Company, Wilmington, Del.

Sheets, rods and tubes.

## MOLDERS, COLD

American Insulator Corp., New Freedom, Pa.

Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

Cutler-Hammer, Inc., Milwaukee, Wis.

Garfield Mfg. Co., Garfield, N. J.

General Electric Co., Plastics Dept., Pittsfield, Mass.

Haveg Corp., Newark, Del.

## PLASTICS CONSULTANTS

J. Earl Simonds, 13 East 31st Street, New York, N. Y.

## PRINTING ON PLASTICS

Anigraphic Process, Inc., New York, N. Y.

# DIRECTORY OF CHEMICALS AND RAW MATERIALS

USED IN THE MANUFACTURE OF PLASTIC COMPOSITIONS UTIL-  
IZED IN THE PRODUCTION OF MOLDED OR FABRICATED PARTS

## ACETIC ANHYDRIDE

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Dow Chemical Co., Midland, Mich.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Tennessee Eastman Corp., Kingsport, Tenn.

## ACETONE

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Cliff Dow Chemical Co., Marquette, Mich.  
Commercial Solvents Corp., New York,  
N. Y.  
du Pont de Nemours & Co., Inc., E. I.,  
Wilmington, Del.  
Kessler Chemical Corp., Hoboken, N. J.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Wishnick-Tumpeer, Inc., New York, N. Y.

## ACETYLENE TETRACHLORIDE

Dow Chemical Co., Midland, Mich.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Innis, Speiden & Co., Inc., New York,  
N. Y.  
U. S. Industrial Chemical Co., Inc., New  
York, N. Y.

## ACID, ABIETIC

Glyco Products Co., Inc., New York, N. Y.  
Hercules Powder Company, Wilmington,  
Del.

## ACID, ACETIC

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
American Cyanamid & Chemical Corp.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Monsanto Chemical Co., St. Louis, Mo.  
Penn Salt Mfg. Co., Philadelphia, Pa.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.  
Shawinigan Products Corp., New York,  
N. Y.  
Tennessee Eastman Corp., Kingsport, Tenn.  
Wishnick-Tumpeer, Inc., New York, N. Y.

## ACID, BUTYRIC

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Innis, Speiden & Co., Inc., New York, N. Y.  
Merck & Co., Inc., Rahway, N. J.

## ACID, CRESYLIC

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
American Cyanamid & Chemical Corp.,  
New York, N. Y.

Barrett Company, New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I.,  
Wilmington, Del.  
Koppers Co., Tar & Chemical Div., Pitts-  
burgh, Pa.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Monsanto Chemical Co., St. Louis, Mo.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.

## ACID, NITRIC

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I.,  
Wilmington, Del.  
General Chemical Co., New York, N. Y.  
Hercules Powder Company, Wilmington,  
Del.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Rubber Products, Inc., Naugatuck  
Chemical Division, New York, N. Y.

## ACID, SEBACIC

National Aniline & Chemical Company, Inc.,  
New York, N. Y.  
Resinous Products & Chemical Co., Inc.,  
Philadelphia, Pa.

## ACID, SULPHURIC

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Atlas Powder Company, Wilmington, Del.  
du Pont de Nemours & Co., Inc., E. I.,  
Wilmington, Del.  
Hercules Powder Company, Wilmington,  
Del.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Rubber Products, Inc., Naugatuck  
Chemical Division, New York, N. Y.

## ALCOHOL

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Hercules Powder Company, Wilmington,  
Del.  
McKesson & Robbins, New York, N. Y.  
Merrimac Chemical Company, Boston,  
Mass.  
Monsanto Chemical Co., St. Louis, Mo.  
Rossville Commercial Alcohol Co., New  
York, N. Y.  
U. S. Industrial Alcohol Co., New York,  
N. Y.

## ALCOHOL-AMYL

Commercial Solvents Corp., New York,  
N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.

Kessler Chemical Corp., Hoboken, N. J.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
Sharples Solvents Corp., Philadelphia, Pa.  
U. S. Industrial Chemical Co., New York,  
N. Y.

## ALCOHOL-BENZYL

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.

## ALCOHOL-BUTYL

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.  
Kessler Chemical Corp., New York, N. Y.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Industrial Chemical Co., New York,  
N. Y.

## ALCOHOL-ETHYL

American Cyanamid & Chemical Corp.,  
N. Y.  
Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
U. S. Industrial Alcohol Co., New York,  
N. Y.  
U. S. Industrial Chemical Co., New York,  
N. Y.

## ALCOHOL-ISOBUTYL

Doe & Ingalls, Inc., Boston, Mass.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.

## ALCOHOL-ISOPROPYL

Advance Solvents & Chemical Corp., New  
York, N. Y.  
Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Doe & Ingalls, Inc., Boston, Mass.  
Merck & Co., Inc., Rahway, N. J.  
U. S. Industrial Chemical Co., Inc., New  
York, N. Y.

## ALCOHOL-METHYL

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
U. S. Industrial Chemical Co., Inc., New  
York, N. Y.

### ALCOHOL-PROPYL

Doe & Ingalls, Inc., Boston, Mass.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.

### ALDEHYDE AMMONIA

du Pont de Nemours & Co. Inc., E. I., Wil-  
mington, Del.

### AMYL ACETATE

Commercial Solvents Corp., New York,  
N. Y.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
Sharples Solvents Corp., Philadelphia, Pa.  
U. S. Industrial Chemical Co., New York,  
N. Y.

### ANILINE DYES

American Aniline Products Inc., New York,  
N. Y.  
Calco Chemical Company, Inc., Bound  
Brook, N. J.  
Dow Chemical Co., Midland, Mich.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
General Dyestuff Corporation, New York,  
N. Y.  
National Aniline & Chemical Co., Inc.,  
New York, N. Y.  
U. S. Rubber Products, Inc., Naugatuck  
Chemical Division, New York, N. Y.

### ASBESTOS

Burnet Co., The, New York, N. Y.  
Johns-Manville, New York, N. Y.  
Keasby & Mattison, Ambler, Pa.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### ASPHALTUM

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
Barber Co., Inc., The, Philadelphia, Pa.  
Carey Co., Philip., Cincinnati, Ohio  
Johns-Manville, New York, N. Y.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### BARIUM HYDRATE

du Pont de Nemours & Co., Inc., E. I.,  
Wilmington, Del.

### BENZALDEHYDE

Cliff Dow Chemical Co., Marquette, Mich.  
Heyden Chemical Corp., New York, N. Y.

### BENZOL

Barrett Co., New York, N. Y.  
Calco Chemical Co., Inc., The, Bound  
Brook, N. J.  
Harshaw Chemical Co., Cleveland, Ohio  
Koppers Co., Tar & Chemical Div., Pitts-  
burgh, Pa.  
Michigan Alkali Co., New York, N. Y.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### BENZYL ACETATE

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Kay-Fries Chemicals, Inc., New York, N. Y.

### BENZYL BENZOATE

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.

Kay-Fries Chemicals, Inc., New York, N. Y.

### BUTYL ACETATE

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Industrial Chemical Co., New York,  
N. Y.

### BUTYL ACETYL RICINOLEATE

Baker Caster Oil Co., Jersey City, N. J.  
Commercial Solvents Corp., New York,  
N. Y.

### BUTYL ETHER

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.

### BUTYL LACTATE

Commercial Solvents Corp., New York,  
N. Y.

### BUTYL STEARATE

Commercial Solvents Corp., New York,  
N. Y.  
Kessler Chemical Corp., Hoboken, N. J.

### BUTYRALDEHYDE

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.

### CADMIUM SULFIDE

American Smelting & Refining Co., New  
York, N. Y.  
Chemical & Pigments Co., Inc., Baltimore,  
Md.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
General Metallic Oxides Co., Jersey City,  
N. J.  
Harshaw Chemical Co., Cleveland, Ohio  
Wishnick-Tumpeper, Inc., New York, N. Y.

### CALCIUM STEARATE

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Harshaw Chemical Co., Cleveland, Ohio  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### CAMPHOR

Dow Chemical Co., Midland, Mich.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.

### CARBON BISULFIDE

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Dow Chemical Co., Midland, Mich.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Harshaw Chemical Co., Cleveland, Ohio  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### CARBON BLACK

Binney & Smith Co., New York, N. Y.  
Burnet Co., The, New York, N. Y.  
Cabot, Inc., Godfrey L., Boston, Mass.  
Calco Chemical Co., Inc., Bound Brook,  
N. J.  
Columbian Carbon Co., New York, N. Y.  
Continental Carbon Co., New York, N. Y.  
United Carbon Co., Charleston, W. Va.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### CARBON TETRACHLORIDE

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Warner Chemical Co., New York, N. Y.  
Wishnick-Tumpeper, Inc., New York, N. Y.

### CASEIN

(Rods-Sheets-Tubes)

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
American Cyanamid & Chemical Corp.,  
New York, N. Y.  
American Plastics Corp., New York, N. Y.  
Harshaw Chemical Co., Cleveland, Ohio  
Hercules Powder Co., Wilmington, Del.  
Innis, Speiden & Co., Inc., New York,  
N. Y.  
Merck & Co., Inc., Rahway, N. J.

### CELLULOSE ACETATE

(Rods-Sheets-Tubes)

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
Celluloid Corp., New York, N. Y.  
Cinelin Company, Indianapolis, Ind.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Fiberloid Corporation, Indian Orchard,  
Mass.  
Insel Co., The, Arlington, N. J.  
Masury & Son, John W., Brooklyn, N. Y.  
Nixon Nitration Works, Nixon, N. J.

### CELLULOSE ACETATE

(Flake)

Hercules Powder Co., Wilmington, Del.  
Tennessee Eastman Corp., Kingsport, Tenn.

### CELLULOSE NITRATE

(Rods-Sheets-Tubes)

Celluloid Corp., New York, N. Y.  
Cinelin Company, Indianapolis, Ind.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Fiberloid Corp., Indian Orchard, Mass.  
Gemloid Corporation, New York, N. Y.  
Insel Co., The, Arlington, N. J.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Nixon Nitration Works, Nixon, N. J.  
Sylvania Industrial Corp., New York, N. Y.

### CHLORINATED RUBBER

Hercules Powder Co., Wilmington, Del.

### COAL TAR COLORS

American Aniline Products, Inc., New York,  
N. Y.  
Calco Chemical Company, Inc., Bound  
Brook, N. J.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.

## COLORS AND PIGMENTS

American Aniline Products, Inc., New York, N. Y.  
American Cyanamid & Chemical Corp., New York, N. Y.  
Binney & Smith Co., New York, N. Y.  
Calco Chemical Co., Inc., Bound Brook, N. J.  
Chemical & Pigments Co., Inc., Baltimore, Md.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
General Dyestuff Corporation, New York, N. Y.  
Glyco Products Co., Inc., New York, N. Y.  
Krebs Pigment and Color Corp., Wilmington, Del.  
Monsanto Chemical Co., St. Louis, Mo.  
Sherwin-Williams Co., Cleveland, Ohio  
Uhlich & Co., Inc., Paul, New York, N. Y.  
Williams & Co., C. K., Easton, Pa.  
Wishnick-Tumpeper, Inc., New York, N. Y.

## CRESOL

American-British Chemical Supplies Inc., New York, N. Y.  
Barrett Co., New York, N. Y.  
Burnet Co., The, New York, N. Y.  
Koppers Co., Tar & Chemical Div., Pittsburgh, Pa.  
Monsanto Chemical Co., St. Louis, Mo.  
Reilly Tar & Chemical Corp., Indianapolis, Ind.

## CROTONALDEHYDE

Carbide & Carbon Chemicals Corp., New York, N. Y.  
Niacet Chemicals Corp., Niagara Falls, N. Y.

## CYCLOHEXANOL

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

## DIACETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Monsanto Chemical Co., St. Louis, Mo.

## DIAMYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
National Aniline & Chemical Co., Inc., New York, N. Y.  
U. S. Industrial Chemical Co., New York, N. Y.

## DIBUTYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.  
American Cyanamid & Chemical Corp., New York, N. Y.  
Carbide & Carbon Chemicals Corp., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
National Aniline & Chemical Co., Inc., New York, N. Y.  
U. S. Industrial Chemical Co., New York, N. Y.

## DIBUTYL TARTRATE

American-British Chemical Supplies, Inc., New York, N. Y.

Commercial Solvents Corp., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.

## DICHLORETHYL ETHER

Carbide & Carbon Chemicals Corp., New York, N. Y.

## DIETHYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Industrial Chemical Co., New York, N. Y.

## DIETHYLENE GLYCOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

## DIMETHYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.  
Carbide & Carbon Chemicals Corp., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Industrial Chemical Co., New York, N. Y.

## DIORTHOTOLYLGUANIDINE (D.O.T.G.)

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

## DIOXANE

Carbide & Carbon Chemicals Corp., New York, N. Y.

## DIPHENYLGUANIDINE (D.P.G.)

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

## DRY COLORS

American Aniline Products, Inc., New York, N. Y.  
Binney & Smith Co., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
General Dyestuff Corp., New York, N. Y.  
Krebs Pigment and Color Corp., Wilmington, Del.  
Sherwin-Williams Co., Cleveland, Ohio  
Williams & Co., C. K., Easton, Pa.  
Wishnick-Tumpeper, Inc., New York, N. Y.

## ESSENCE, PEARL

Celluloid Corp., New York, N. Y.  
Hudson Pearl Co., New York, N. Y.  
Meyer Bros. Co., Jos. H., Brooklyn, N. Y.  
Mearl Corp., The, New York, N. Y.  
Paispearl Products, New York, N. Y.

## ETHYL ACETATE

Carbide & Carbon Chemicals Corp., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
Mallinckrodt Chemical Works, St. Louis, Mo.

Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
U. S. Industrial Chemical Co., New York, N. Y.

## ETHYLALCOHOL—COMPLETELY DENATURED AND SPECIALLY DENATURED

American Cyanamid & Chemical Corp., New York, N. Y.  
Carbide & Carbon Chemicals Corp., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
U. S. Industrial Alcohol Co., New York, N. Y.  
U. S. Industrial Chemical Co., New York, N. Y.

## ETHYLCELLULOSE

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Hercules Powder Co., Wilmington, Del.

## ETHYL FORMATE

American-British Chemical Supplies, Inc., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.

## ETHYL LACTATE

American Cyanamid & Chemical Corp., New York, N. Y.  
U. S. Industrial Chemical Co., New York, N. Y.

## ETHYLENE DIAMINE

Carbide & Carbon Chemicals Corp., New York, N. Y.

## ETHYLENE DICHLORIDE

Carbide & Carbon Chemicals Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

## ETHYLENE GLYCOL

Carbide & Carbon Chemical Corp., New York, N. Y.

## FILLERS, ASBESTOS

International Pulp Co., New York, N. Y.  
Johns-Manville, New York, N. Y.

## FILLERS, COTTON FLOCK

Claremont Waste Mfg. Co., Claremont, N. H.  
Peckham Mfg. Co., The, Newark, N. J.  
Rayon Processing Co., The, Central Falls, R. I.

## FILLERS, RAYON FLOCK

Rayon Processing Co., The, Central Falls, R. I.

## FILLERS, SILICA, DIATOMACEOUS

International Pulp Co., New York, N. Y.  
Johns-Manville, New York, N. Y.  
Loomis, W. H. Talc Corp., The, Gouverneur, N. Y.  
Wishnick-Tumpeper, Inc., New York, N. Y.

## FILLERS, WOODFLOUR

American Woodflour Co., Inc., New York, N. Y.

Becker, Moore & Co., Inc., North Tonawanda, N. Y.  
Brown Co., Portland, Maine  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Lignum Chemical Works, The, Brooklyn, N. Y.  
State Chemical Co., New York, N. Y.

#### FORMALDEHYDE

American-British Chemical Supplies, Inc., New York, N. Y.  
American Cyanamid & Chemical Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Hercules Powder Co., Wilmington, Del.  
Heyden Chemical Corp., New York, N. Y.  
Mallinckrodt Chemical Works, St. Louis, Mo.  
Merck & Co., Inc., Rahway, N. J.

#### FUMARIC ACID

National Aniline & Chemical Co., New York, N. Y.

#### FURFURAL

Quaker Oats Co., Chicago, Ill.

#### GLYCERINE

American-British Chemical Supplies, Inc., New York, N. Y.

#### HEXAMINE

American-British Chemical Supplies, Inc., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Heyden Chemical Corp., New York, N. Y.

#### HEXAMETHYLENETETRAMINE

American-British Chemical Supplies, Inc., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Heyden Chemical Corp., New York, N. Y.  
Mallinckrodt Chemical Works, St. Louis, Mo.  
Merck & Co., Inc., Rahway, N. J.  
Wishnick-Tumpeier, Inc., New York, N. Y.

#### ISOBUTYRIC ACID

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

#### IRON OXIDE—BLACK, BROWN, RED AND YELLOW

American Cyanamid & Chemical Corp., New York, N. Y.  
Binney & Smith Co., New York, N. Y.  
Burnet Co., The, New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
General Dyestuff Corp., New York, N. Y.  
Mallinckrodt Chemical Works, St. Louis, Mo.  
Merck & Co., Inc., Rahway, N. J.  
Williams & Co., C. K., Easton, Pa.  
Wishnick-Tumpeier, Inc., New York, N. Y.

#### KIESELGUHR

American Cyanamid & Chemical Corp., New York, N. Y.  
Carey Co., Philip, Cincinnati, Ohio  
Dicalite Company, New York, N. Y.  
Johns-Manville, New York, N. Y.  
Wishnick-Tumpeier, Inc., New York, N. Y.

#### LACQUER SOLVENTS

American-British Chemical Supplies, Inc., New York, N. Y.  
American Cyanamid & Chemical Corp., New York, N. Y.  
Bakelite Corp., New York, N. Y.  
Carbide & Carbon Chemicals Corp., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Monsanto Chemical Co., St. Louis, Mo.  
Stanley Chemical Co., East Berlin, Conn.  
U. S. Industrial Alcohol Co., Inc., New York, N. Y.

#### LACQUERS—BAKING TYPE

Bakelite Corp., New York, N. Y.  
General Plastics, Inc., North Tonawanda, N. Y.  
Makalot Corp., Boston, Mass.

#### LACQUERS, CELLULOSE ACETATE

Masury & Son, John W., Brooklyn, N. Y.

#### LACQUERS, NITROCELLULOSE

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Eastman Kodak Co., Rochester, N. Y.  
Egyptian Lacquer Mfg. Co., New York, N. Y.  
Fiberloid Corp., Indian Orchard, Mass.  
Maas & Waldstein Co., Newark, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
Pyroxylin Products Corp., Chicago, Ill.  
Roxalin Flexible Lacquer Co., Inc., Elizabeth, N. J.  
Stanley Chemical Co., East Berlin, Conn.

#### LAMINATING PAPER

Hurlbut Paper Co., South Lee, Mass.  
Warren Co., S. D., Boston, Mass.

#### LATEX (Liquid Rubber)

Heveatex Corp., Melrose, Mass.  
U. S. Rubber Products, Inc., New York, N. Y.

#### LIQUID RESINS

Bakelite Corp., New York, N. Y.  
Beck, Koller & Co., Inc., Detroit, Mich.  
Commercial Solvents Corp., New York, N. Y.  
Durite Plastics, Philadelphia, Pa.  
Fiberloid Corp., Indian Orchard, Mass.  
General Plastics, Inc., North Tonawanda, N. Y.  
Glyco Products Co., Inc., New York, N. Y.  
Hercules Powder Co., Wilmington, Del.  
Makalot Corp., Boston, Mass.  
Resinox Corp., New York, N. Y.

#### MALEIC ANHYDRIDE (Toxic Anhydride Acid)

Monsanto Chemical Co., St. Louis, Mo.  
National Aniline & Chemical Co., Inc., New York, N. Y.

#### MESITYL OXIDE

Commercial Solvents Corp., New York, N. Y.

#### METHANOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

Commercial Solvents Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Mallinckrodt Chemical Works, St. Louis, Mo.  
Merck & Co., Inc., Rahway, N. J.  
National Oil & Supply Co., Newark, N. J.  
Tennessee Eastman Corp., Kingsport, Tenn.  
U. S. Industrial Chemical Co., Inc., New York, N. Y.

#### METHYL ACETATE

Advance Solvents & Chemical Corp., New York, N. Y.  
Carbide & Carbon Chemicals Corp., New York, N. Y.  
Ford Motor Co., Iron Mountain, Mich.

#### METHYL ACETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Tennessee Eastman Corp., Kingsport, Tenn.  
U. S. Industrial Chemical Co., New York, N. Y.

#### METHYL AMYL ALCOHOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

#### METHYL AMYL KETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.

#### METHYL FORMATE

American-British Chemical Supplies, Inc., New York, N. Y.  
Commercial Solvents Corp., New York, N. Y.  
Kay-Fries Chemicals, Inc., New York, N. Y.

#### METHYL HEXYL KETONE

Resinous Products & Chemical Co., Philadelphia, Pa.

#### METHYL ISOBUTYL KETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.

#### METHYL—LACTATE

Commercial Solvents Corp., New York, N. Y.

#### METHYL METHACRYLATE

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
Resinous Products & Chemical Co., Philadelphia, Pa.  
Rohm & Haas Co., Philadelphia, Pa.

#### METHYLAMINES

Commercial Solvents Corp., New York, N. Y.  
Rohm & Haas Co., Philadelphia, Pa.

#### MICA

American Cyanamid & Chemical Corp., New York, N. Y.  
Burnet Co., The, New York, N. Y.  
Harshaw Chemical Co., Cleveland, Ohio  
Maryland Chemical Co., Baltimore, Md.  
Mica Insulator Co., New York, N. Y.  
Munsell, Eugene & Co., New York, N. Y.  
Wishnick-Tumpeier, Inc., New York, N. Y.

#### MINERAL BLACK

Binney & Smith Co., New York, N. Y.

Williams & Co., C. K., Easton, Pa.  
Wishnick-Tumpeier, Inc., New York, N. Y.

### MOLDING & LAMINATING BOARDS AND BLANKS

Bakelite Corp., New York, N. Y.  
Bakelite-Rogers Co. Inc., Manchester, Conn.

### MOLDING COMPOUNDS, CELLULOSE ACETATE

Celluloid Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Fiberloid Corp., Indian Orchard, Mass.  
Masury, John W. & Son, Brooklyn, N. Y.  
Nixon Nitration Works, Nixon, N. J.  
Tennessee Eastman Corp., Kingsport, Tenn.

### MOLDING COMPOUNDS, PHENOL-FURFURAL

Durite Plastics, Philadelphia, Pa.

### MOLDING COMPOUNDS PHENOL-FORMALDEHYDE

Bakelite Corp., New York, N. Y.  
Catalin Corp., New York, N. Y.  
Durite Plastics, Philadelphia, Pa.  
General Plastics, Inc., North Tonawanda,  
N. Y.  
Makalot Corp., Boston, Mass.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.  
Resinox Corp., New York, N. Y.

### MOLDING COMPOUNDS, STYRENE

Carbide & Carbon Chemicals Corp., New  
York, N. Y.

### MOLDING COMPOUNDS, UREA-FORMALDEHYDE

Beetle Products Division of American Cyan-  
amid Co., New York, N. Y.  
Plaskon Co., Inc., Toledo, Ohio  
Resinous Products & Chemical Co., Phila-  
delphia, Pa.

### MOLDING COMPOUNDS, VINYL RESINS

Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Shawinigan Prods. Corp., New York, N. Y.

### NAPHTHALENE

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
Barrett Company, New York, N. Y.  
Burnet Co., The, New York, N. Y.  
Calco Chemical Co., The, Bound Brook,  
N. J.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Koppers Co., Tar & Chemical Div., Pitts-  
burgh, Pa.  
Monsanto Chemical Co., St. Louis, Mo.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.

### NITROCELLULOSE

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Atlas Powder Co., Wilmington, Del.  
Celluloid Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Eastman Kodak Co., Rochester, N. Y.  
Fiberloid Corp., Indian Orchard, Mass.  
Hercules Powder Company, Wilmington,  
Del.

Merrimac Chemical Co., Boston, Mass.  
Sylvania Industrial Corp., New York, N. Y.  
Zapon Co., Stamford, Conn.

### OIL, SOY BEAN

American Soya Products Corp., Evansville,  
Ind.  
Staley Mfg. Co., A. E., Decatur, Ill.

### PARA-FORMALDEHYDE

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Heyden Chemical Corp., New York, N. Y.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.

### PHENOL

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Barrett Company, New York, N. Y.  
Dow Chemical Co., Midland, Mich.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Heyden Chemical Corp., New York, N. Y.  
Koppers Co., Tar & Chemical Div., Pitts-  
burgh, Pa.  
Mallinckrodt Chemical Works, St. Louis,  
Mo.  
Merck & Co., Inc., Rahway, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.

### PHTHALIC ANHYDRIDE

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Monsanto Chemical Co., St. Louis, Mo.  
National Aniline & Chemical Co., Inc., New  
York, N. Y.

### PLASTICIZERS

American-British Chemical Supplies, Inc.,  
New York, N. Y.  
American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Beck, Koller & Co., Inc., Detroit, Mich.  
Carbide & Carbon Chemicals Corp., New  
York, N. Y.  
Celluloid Corp., New York, N. Y.  
Commercial Solvents Corp., New York,  
N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Glyco Products Co., Inc., New York, N. Y.  
Hercules Powder Co., Wilmington, Del.  
Kay-Fries Chemicals, Inc., New York, N. Y.  
Kessler Chemical Corp., Hoboken, N. J.  
Monsanto Chemical Co., St. Louis, Mo.  
National Aniline & Chemical Co., Inc., New  
York, N. Y.  
Ohio-Apex, Inc., Nitro, W. Va.  
Resinous Products & Chemical Co., Phila-  
delphia, Pa.  
U. S. Industrial Chemical Co., Inc., New  
York, N. Y.

### PYROPHYLLITE

du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.

### PYROXYLIN

(See Cellulose Nitrate)

### RESIN BONDS FOR PLYWOODS AND VENEERS

Bakelite Corp., New York, N. Y.

Beetle Products Div. of American Cyanamid  
Co., New York, N. Y.  
Catalin Corp., New York, N. Y.  
Durite Plastics, Philadelphia, Pa.  
General Plastics, Inc., North Tonawanda,  
N. Y.  
Makalot Corp., Boston, Mass.  
Resinous Products & Chemical Co., Phila-  
delphia, Pa.

### RESIN SOLUTIONS

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Bakelite Corp., New York, N. Y.  
Beck, Koller & Co., Inc., Detroit, Mich.  
Beetle Products Division, American Cyan-  
amid Co., New York, N. Y.  
Catalin Corp., New York, N. Y.  
Durite Plastics, Philadelphia, Pa.  
General Plastics, Inc., North Tonawanda,  
N. Y.  
Makalot Corp., Boston, Mass.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.  
Resinous Products & Chem. Co., Philadel-  
phia, Pa.  
Resinox Corp., New York, N. Y.  
Rohm & Haas Co., Inc., Philadelphia, Pa.

### RESINS, CAST

Bakelite Corp., New York, N. Y.  
Catalin Corp., New York, N. Y.  
du Pont de Nemours & Co., Inc., E. I., Wil-  
mington, Del.  
Fiberloid Corp., Indian Orchard, Mass.  
Marblette Corp., Long Island City, N. Y.  
Rohm & Haas Co., Philadelphia, Pa.

### RESINS, GLYCEROL

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Bakelite Corp., New York, N. Y.  
Beck, Koller & Co., Inc., Detroit, Mich.  
General Electric Co., Plastics Dept., Pitts-  
field, Mass.  
Glyco Products Co., Inc., New York, N. Y.  
Makalot Corp., Boston, Mass.  
Resinous Products & Chemical Co., Phila-  
delphia, Pa.

### RESINS, OIL SOLUBLE

Bakelite Corp., New York, N. Y.  
Beck, Koller & Co., Inc., Detroit, Mich.  
Beetle Products Div., American Cyanamid  
Co., New York, N. Y.  
Durite Plastics, Philadelphia, Pa.  
General Plastics, Inc., North Tonawanda,  
N. Y.  
Makalot Corp., Boston, Mass.  
Resinox Corp., New York, N. Y.

### RESINS, PHENOL

American Cyanamid & Chemical Corp.,  
New York, N. Y.  
Bakelite Corp., New York, N. Y.  
Beck, Koller & Co., Inc., Detroit, Mich.  
Durite Plastics, Philadelphia, Pa.  
Fiberloid Corp., Indian Orchard, Mass.  
General Plastics, Inc., North Tonawanda,  
N. Y.  
Makalot Corp., Boston, Mass.  
Reilly Tar & Chemical Corp., Indianapolis,  
Ind.  
Resinous Products & Chemical Co., Phila-  
delphia, Pa.  
Resinox Corp., New York, N. Y.  
Rohm & Haas Co., Philadelphia, Pa.

### RESINS, SYNTHETIC

(See also Molding Compounds)

American Cyanamid & Chemical Corp.,  
New York, N. Y.

Bakelite Corp., New York, N. Y.  
 Beck, Koller & Co., Inc., Detroit, Mich.  
 Beetle Products Division, American Cyanamid Co., New York, N. Y.  
 Carbide & Carbon Chemicals Corp., New York, N. Y.  
 Catalin Corp., New York, N. Y.  
 Celluloid Corp., New York, N. Y.  
 du Pont de Nemours, Inc., E. I., Wilmington, Del.  
 Durite Plastics, Philadelphia, Pa.  
 Fiberloid Corp., Indian Orchard, Mass.  
 General Electric Co., Plastics Dept., Pittsfield, Mass.  
 General Plastics, Inc., North Tonawanda, N. Y.  
 Glyco Products Co., Inc., New York, N. Y.  
 Goodyear Tire & Rubber Co., Akron, Ohio (Rubber Derivative)  
 Hercules Powder Company, Wilmington, Del.  
 Makalot Corp., Boston, Mass.  
 Marblette Corp., Long Island City, N. Y.  
 Monsanto Chemical Co., St. Louis, Mo.  
 Plaskon Co., Inc., Toledo, Ohio  
 Reilly Tar & Chemical Corp., Indianapolis, Ind.  
 Resinous Products & Chemical Co., Philadelphia, Pa.  
 Resinox Corp., New York, N. Y.  
 Rohm & Haas Company, Philadelphia, Pa.  
 Shawinigan Products Corp., New York, N. Y.  
 Tennessee Eastman Corp., Kingsport, Tenn.

#### RESIN TREATED FABRICS

Altas Powder Co., Zapon Division, Stamford, Conn. Revolite asbestos, for laundry roll covers and industrial uses, resinoid processed.

#### RESINS, UREA

American Cyanamid & Chemical Corp., New York, N. Y.  
 Beetle Products Division, American Cyanamid Co., New York, N. Y.  
 Glyco Products Co., Inc., New York, N. Y.  
 Plaskon Co., Inc., Toledo, Ohio  
 Resinous Products & Chemical Co., Philadelphia, Pa.

#### RESINS, VARNISH MAKING

American Cyanamid & Chemical Corp., New York, N. Y.  
 Bakelite Corp., New York, N. Y.  
 Beck, Koller & Co., Inc., Detroit, Mich.  
 Beetle Products Div., American Cyanamid Corp., New York, N. Y.  
 Commercial Solvents Corp., New York, N. Y.  
 Durite Plastics, Philadelphia, Pa.  
 General Plastics, Inc., North Tonawanda, N. Y.  
 Hercules Powder Company, Wilmington, Del.  
 Makalot Corp., Boston, Mass.  
 Resinox Corp., New York, N. Y.

#### RESORCIN

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
 General Dyestuff Corp., New York, N. Y.  
 Mallinckrodt Chemical Works, St. Louis, Mo.  
 Merck & Co., Inc., Rahway, N. J.  
 National Aniline & Chemical Co., Inc., New York, N. Y.

#### ROLL LEAF (Stamping Foil)

Griffin, Campbell, Hayes, Walsh, Inc., New York, N. Y.

Peerless Roll Leaf Co., Inc., Union City, N. J.

#### ROSIN

Doe & Ingalls, Inc., Boston, Mass.  
 Hercules Powder Co., Wilmington, Del.

#### RUBBER, SYNTHETIC MOLDING

Thiokol Corp., Yardville, N. J.

#### SCRAP, ACETATE AND NITRATE

American Products Mfg. Co., New Orleans, La.  
 Atlantic Pyroxylin Waste Co., Arlington, N. J.  
 Celluloid Corp., New York, N. Y.  
 Eastman Kodak Co., Rochester, N. Y.  
 Fiberloid Corp., Indian Orchard, Mass.  
 Gering Products, Inc., Rahway, N. J.  
 Jefferys & Co., Ltd., Burbank, Calif.  
 Limck, Green & Reed, Inc., Chicago, Ill.  
 Moses Sereinsky Co., Indianapolis, Ind.

#### STEARATE, ALUMINUM

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

#### TALC

American Cyanamid & Chemical Corp., New York, N. Y.  
 Baker Chemical Co., J. T., Phillipsburg, N. J.  
 Binney & Smith Co., New York, N. Y.  
 du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
 International Pulp Co., New York, N. Y.  
 Loomis Talc Corp., W. H. Gouverneur, N. Y.  
 Mallinckrodt Chemical Works, St. Louis, Mo.  
 Merck & Co., Inc., Rahway, N. J.  
 Williams & Co., C. K., Easton, Pa.  
 Wishnick-Tumpeer, Inc., New York, N. Y.

#### TAR, COAL

Barrett Company, New York, N. Y.  
 Cabot, Inc., Samuel, Boston, Mass.  
 Koppers Co., Tar & Chemical Div., Pittsburgh, Pa.  
 Monsanto Chemical Co., St. Louis, Mo.  
 Reilly Tar & Chemical Corp., Indianapolis, Ind.

#### THIOUREA

American Cyanamid & Chemical Corp., New York, N. Y.  
 Doe & Ingalls, Inc., Boston, Mass.  
 Merck & Co., Inc., Rahway, N. J.  
 National Aniline & Chemical Co., Inc., New York, N. Y.

#### TITANIUM DIOXIDE

Klebs Pigment and Color Corp., Wilmington, Del.

#### TOLUOL

American-British Chemical Supplies, Inc., New York, N. Y.  
 Barrett Company, New York, N. Y.  
 Calco Chemical Co., Inc., Bound Brook, N. J.  
 Koppers Co., Tar & Chemical Div., Pittsburgh, Pa.  
 Mallinckrodt Chemical Works, St. Louis, Mo.  
 Merck & Co., Inc., Rahway, N. J.  
 Monsanto Chemical Co., St. Louis, Mo.

#### TRIACETIN

American-British Chemical Supplies, Inc., New York, N. Y.  
 Doe & Ingalls, Inc., Boston, Mass.  
 Kay-Fries Chemicals, Inc., New York, N. Y.  
 Kessler Chemical Corp., Hoboken, N. J.

#### TRIBUTYL CITRATE AND PHOSPHATE

Commercial Solvents Corp., New York, N. Y.

#### TRIETHANOLAMINE

Carbide & Carbon Chemicals Corp., New York, N. Y.

#### TRIETHYL PHOSPHATE

Commercial Solvents Corp., New York, N. Y.

#### TRIETHYLENE GLYCOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

#### TRIPHENYL GUANIDINE (T. P. G.)

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

#### TRIPHENYL PHOSPHATE

American-British Chemical Supplies, Inc., New York, N. Y.

#### UREA

Advance Solvents & Chemical Corp., New York, N. Y.  
 American Cyanamid & Chemical Corp., New York, N. Y.  
 du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
 General Dyestuff Corp., New York, N. Y.  
 Mallinckrodt Chemical Works, St. Louis, Mo.  
 Merck & Co., Inc., Rahway, N. J.

#### VINYL, RESINS

Carbide & Carbon Chemicals Corp., New York, N. Y.  
 Shawinigan Products Corp., New York, N. Y.

#### WOODFLOUR

American Woodflour Co., Inc., New York, N. Y.  
 Becker, Moore & Co., North Tonawanda, N. Y.  
 Burnet Co., The, New York, N. Y.  
 Composition Materials Co., Inc., New York, N. Y.  
 Doe & Ingalls, Inc., Boston, Mass.  
 du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.  
 Innis, Speiden & Co., Inc., New York, N. Y.  
 Lignum Chemical Works, The, Brooklyn, N. Y.  
 Soberski, B. L., New York, N. Y.  
 State Chemical Co., New York, N. Y.  
 Wishnick-Tumpeer, Inc., New York, N. Y.

#### XYLOL

Calco Chemical Co., Inc., The, Bound Brook, N. J.

# DIRECTORY OF TRADE NAMES

AND MANUFACTURERS OF PLASTICS LISTED IN PROPERTIES CHART

## Phenol-Formaldehyde Molding Compounds

|                  |   |
|------------------|---|
| <b>Bakelite</b>  | Bakelite Corp., 247 Park Ave., New York   |
| <b>Catalin</b>   | Catalin Corp., 1 Park Ave., New York  |
| <b>Durez</b>     | General Plastics Inc., 710 E. Walck Rd., N. Tonawanda, N. Y.<br>N. Y. office: 250 Park Ave. |
| <b>Durite</b>    | Durite Plastics, 5010 Summerdale Ave. (near Roosevelt B'ldg.), Philadelphia, Pa.            |
| <b>Indur</b>     | Reilly Tar & Chemical Corp., 500 Fifth Ave., New York, N. Y.                                |
| <b>Insurak</b>   | Richardson Co., 2707 Lake St., Melrose Park (Chicago), Ill.<br>N. Y. office: 75 West St.    |
| <b>Keynite</b>   | Waterbury Button Co., Waterbury, Conn.<br>N. Y. office: 1133 B'way.                         |
| <b>Makalot</b>   | Makalot Corp., 262 Washington St., Boston, Mass.  |
| <b>Moldite</b>   | Moldite Corp., 345 W. 35th St., New York, N. Y.   |
| <b>Resinox</b>   | Resinox Corp., 230 Park Ave., New York  |
| <b>Textolite</b> | General Electric Co., Plastics Dept., Pittsfield, Mass.                                     |
| <b>Uniplast</b>  | Universal Plastics Co., 235 Jersey Ave., New Brunswick, N. J.                               |

## Phenol-Formaldehyde Laminated Products

|                  |  |
|------------------|--|
| <b>Aqualite</b>  | National Vulcanized Fibre Co., Wilmington, Del.  |
| <b>Dilecto</b>   | Continental Diamond Fibre Co., Newark, Del.<br>N. Y. office: 230 Park Ave.               |
| <b>Duraloy</b>   | Detroit Paper Products Corp., Detroit  |
| <b>Fibroc</b>    | Fibroc Insulation Co., Valparaiso, Ind.  |
| <b>Formica</b>   | Formica Insulation Co., 4671 Spring Grove Ave., Cincinnati, Ohio                         |
| <b>Insurak</b>   | Richardson Co., 2707 Lake St., Melrose Park (Chicago), Ill.<br>N. Y. office: 75 West St. |
| <b>Lamicaid</b>  | Mica Insulator Co., 200 Varick St., New York, N. Y.                                      |
| <b>Micarta</b>   | Westinghouse Electric & Mfg. Co., Micarta Div., Trafford, Pa.                            |
| <b>Ohmoid</b>    | Wilmington Fibre Specialty Co., East Wilmington, Del.                                    |
| <b>Penelyte</b>  | Penelyte Corp., 230 Park Ave., New York  |
| <b>Phenolite</b> | National Vulcanized Fibre Co., Wilmington, Del.  |
| <b>Spauldite</b> | Spaulding Fibre Co., 313 Wheeler St., Tonawanda, N. Y.<br>N. Y. office: 484 Broome St.   |
| <b>Synthene</b>  | Synthene Corp., Oaks, Pa.  |
| <b>Taylor</b>    | Taylor Fibre Co., Inc., Norristown, Pa.<br>N. Y. office: 90 West St.                     |
| <b>Textolite</b> | General Electric Co., Plastics Dept., Pittsfield, Mass.                                  |

## Phenol-Formaldehyde Cast Resins

|                  |   |
|------------------|---|
| <b>Bakelite</b>  | Bakelite Corp., 247 Park Ave., New York   |
| <b>Catalin</b>   | Catalin Corp., 1 Park Ave., New York  |
| <b>Fiberlon</b>  | Fiberlon Corp., Indian Orchard, Mass.<br>N. Y. office: 60 E. 42nd St.   |
| <b>Marblette</b> | Marblette Corp., 37-21 30th St., Long Island City, N. Y.  |
| <b>Phenalin</b>  | E. I. du Pont de Nemours & Co., Inc., Plastics Dept., 626 Schuyler Ave., Arlington, N. J.<br>N. Y. office: 350 Fifth Ave. |

## Phenol-Furfural Resins

|               |  |
|---------------|--|
| <b>Durite</b> | Durite Plastics, 5010 Summerdale Ave. (near Roosevelt B'ldg.), Philadelphia, Pa. |
|---------------|--|

## Urea-Formaldehyde Molding Compounds

|                |  |
|----------------|--|
| <b>Beetle</b>  | Beetle Products Div., American Cyanamid Co., 30 Rockefeller Pl., New York        |
| <b>Harvite</b> | Siemon Co., Bridgeport, Conn.<br>N. Y. office: 145 Varick St.                    |
| <b>Plaskon</b> | Plaskon Co. Inc., 2112 Sylvan Ave., Toledo, Ohio<br>N. Y. office: 41 E. 42nd St. |
| <b>Unyte</b>   | Do.  |

## Urea-Formaldehyde Laminated Products

|                  |  |
|------------------|--|
| <b>Beetle</b>    | Beetle Products Div., American Cyanamid Co., 30 Rockefeller Pl., New York  |
| <b>Dilophane</b> | Continental Diamond Fibre Co., Newark, Del.<br>N. Y. office: 230 Park Ave. |
| <b>Formica</b>   | Formica Insulation Co., 4671 Spring Grove Ave., Cincinnati, Ohio           |
| <b>Micarta</b>   | Westinghouse Electric & Mfg. Co., Micarta Div., Trafford, Pa.              |

## Vinyl Resins

|              |  |
|--------------|--|
| <b>Alvar</b> | Shawinigan Products Corp., 350 Fifth Ave., New York, N. Y. |
|--------------|--|

|                          |  |
|--------------------------|--|
| <b>Formvar</b>           | Do.  |
| <b>Gelva</b>             | Do.  |
| <b>Mowilith</b>          | Advance Solvents & Chemical Corp., 245 Fifth Ave., New York, N. Y. |
| <b>(Made in Germany)</b> |  |
| <b>Vinylite</b>          | Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y.  |

## Acrylate and Methacrylate Resins

|                   |  |
|-------------------|--|
| <b>Crystalite</b> | (Molding compound) Röhm & Haas Co., Inc., 222 W. Washington Square, Philadelphia   |
| <b>Lecite</b>     | (Molding compound & cast resin) E. I. du Pont de Nemours & Co. Inc., Plastics Dept., 626 Schuyler Ave., Arlington, N. J.<br>N. Y. office: 350 Fifth Ave. |
| <b>Plaxiglas</b>  | (Cast resin) Röhm & Haas Co. Inc., 222 W. Washington Square, Philadelphia  |

## Styrene Resins

|                  |   |
|------------------|---|
| <b>Rezo plas</b> | Advance Solvents & Chemical Corp., 245 Fifth Ave., New York, N. Y.                  |
| <b>Trolitul</b>  | (Made in Germany) Adam Bernhard, 45 E. 17th St., New York, N. Y.                    |
| <b>Victron</b>   | (Made in Germany) Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y. |

## Shellac Compounds

|                   |   |
|-------------------|---|
| <b>Compo-Site</b> | Compo-Site Inc., 207 Astor St., Newark, N. J.   |
| <b>Lacalite</b>   | Consolidated Molded Products Corp., 1935 Case St., Scranton, Pa.<br>N. Y. office: 1776 B'way. |
| —                 | T. F. Butterfield Inc., 58 Rubber St., Naugatuck, Conn.<br>N. Y. office: 303 Fifth Ave.       |
| —                 | Waterbury Button Co., Waterbury, Conn.<br>N. Y. office: 1133 B'way.                           |

## Cold Molded—Bituminous Type (Non-Refractory)

|                             |   |
|-----------------------------|---|
| <b>Braylite</b>             | American Insulator Corp., 1930 Main St., New Freedom, Pa.<br>N. Y. office: 101 Park Ave.  |
| <b>Cetec-Non-Refractory</b> | General Electric Co., Plastics Dept., Pittsfield, Mass.                                   |
| <b>Ebrok</b>                | Richardson Co., 2707 Lake St., Melrose Park (Chicago), Ill.<br>N. Y. office: 75 West St.  |
| <b>Gummon</b>               | Garfield Mfg. Co., Wallington Rd., Garfield, N. J.  |
| <b>Hemite</b>               | Do.   |
| <b>Stoeo</b>                | Joseph Stokes Rubber Co., 322 Webster St., Trenton, N. J.                                 |
| <b>Thermoplax</b>           | Cutler-Hammer Inc., 1333 W. St. Paul Ave., Milwaukee, Wis.<br>N. Y. office: 8 W. 40th St. |

## Cold Molded—Ceramic Type (Refractory)

|                         |   |
|-------------------------|---|
| <b>Alphide</b>          | Standard Plastics Corp., 108 B'way, Jersey City, N. J.  |
| <b>Cetec-Refractory</b> | General Electric Co., Plastics Dept., Pittsfield, Mass.   |
| <b>Coltstone</b>        | Colt's Patent Fire Arms Mfg. Co., 1935 Van Dyke Ave., Hartford, Conn.<br>N. Y. office: 20 Vesey St. |
| <b>Pyroplax</b>         | Cutler-Hammer Inc., 1333 W. St. Paul Ave., Milwaukee, Wis.<br>N. Y. office: 8 W. 40th St.           |

## Rubber Derivatives and Rubber-like Resins

|                 |  |
|-----------------|--|
| <b>Anarite</b>  | Aqueous dispersion synthetic rubber  |
| <b>Corprene</b> | Synthetic rubber with ground cork  |
| <b>Flamenol</b> | Vinyl chloride resin   |
| <b>Koroseal</b> | Vinyl  |
|                 | American Anode Inc., Wilmington, Del.  |
|                 | Armstrong Cork Products Co., Liberty St., Lancaster, Pa.<br>N. Y. office: 295 Fifth Ave. |
|                 | General Electric Co., 1 River Rd., Schenectady, N. Y.                                    |
|                 | B. F. Goodrich Co., 450 S. Main St., Akron, Ohio<br>N. Y. office: 795 Eleventh Ave.      |

|                 |  |
|-----------------|--|
| <b>Marbo</b>    | Chlorinated rubber   |
| <b>Marbon</b>   | Do.  |
| <b>Neoprene</b> | Chlorobutadiene  |
|                 | Do.  |
|                 | E. I. du Pont de Nemours & Co., Inc., 11th & Orange Sts., Wilmington, Del.<br>N. Y. office: 350 Fifth Ave. |
| <b>Pliofilm</b> | Rubber hydrochloride   |
|                 | Goodyear Tire & Rubber Co., Inc., 1400 Cartwright St., Akron, Ohio<br>N. Y. office: 600 W. 58th St.        |
| <b>Pliofom</b>  | Modified isomerized rubber   |
|                 | Do.  |
| <b>Pliolite</b> | Do.  |
| <b>Thiokol</b>  | Oil-soluble polysulfide  |
| <b>Tornesit</b> | Chlorinated rubber   |
|                 | Do.  |
|                 | Thiokol Corp., 37 Down St., Yardville, N. J.   |
|                 | Hercules Powder Co., 999 Market St., Wilmington, Del.<br>N. Y. office: 20 E. 40th St.                      |

## Hard Rubber

|                 |  |
|-----------------|--|
| <b>Ace-lite</b> | American Hard Rubber Co., Howard & Mercer Sts., New York, N. Y.                          |
| <b>Luzerne</b>  | Luzerne Rubber Co., Dewey St., Trenton, N. J.  |
| <b>Rubtex</b>   | Richardson Co., 2707 Lake St., Melrose Park (Chicago), Ill.<br>N. Y. office: 75 West St. |
| —               | Joseph Stokes Rubber Co., 322 Webster St., Trenton, N. J.                                |
| —               | Vulcanized Rubber Co., 2 E. 29th St., New York, N. Y.                                    |

## Casein

|                   |   |
|-------------------|---|
| <b>Aladdinite</b> | Aladdinite Corp., 261 Wallace St., Orange, N. J.          |
| <b>Ameroid</b>    | American Plastics Corp., 50 Union Square, New York, N. Y. |

## Ethylcellulose

|                |   |
|----------------|---|
| <b>Ethocel</b> | Dow Chemical Co., 219 Jefferson Ave., Midland, Mich.                                  |
| —              | Hercules Powder Co., 999 Market St., Wilmington, Del.<br>N. Y. office: 20 E. 40th St. |

## Cellulose Acetate

|                  |  |
|------------------|--|
| <b>Fibestos</b>  | Fiberloid Corp., Indian Orchard, Mass.<br>N. Y. office: 60 E. 42nd St.   |
| <b>Lumarith</b>  | Celluloid Corp., 10 E. 40th St., New York, N. Y.   |
| <b>Masuron</b>   | John W. Masury & Son, 50 Jay St., Brooklyn, N. Y.  |
| <b>Nixonite</b>  | Nixon Nitration Works, 125 Murray St., East Nixon, N. J.   |
| <b>Plastocel</b> | E. I. du Pont de Nemours & Co. Inc., Plastics Dept., 626 Schuyler Ave., Arlington, N. J.<br>N. Y. office: 350 Fifth Ave. |
| <b>Tenite</b>    | Tennessee Eastman Corp., Kingsport, Tenn.<br>N. Y. office: 171 Madison Ave.  |

## Nitrocellulose (Pyroxilin)

|                  |  |
|------------------|--|
| <b>Celluloid</b> | Celluloid Corp., 10 E. 40th St., New York, N. Y.   |
| <b>Fiberloid</b> | Fiberloid Corp., Indian Orchard, Mass.<br>N. Y. office: 60 E. 42nd St.   |
| <b>Nixonoid</b>  | Nixon Nitration Works, 125 Murray Ave., East Nixon, N. J.  |
| <b>Pyralin</b>   | E. I. du Pont de Nemours & Co. Inc., Plastics Dept., 626 Schuyler Ave., Arlington, N. J.<br>N. Y. office: 350 Fifth Ave. |

## Cumaron-Indene Resins

|                      |  |
|----------------------|--|
| <b>Cumar</b>         | Barrett Co., 40 Rector St., New York, N. Y.              |
| <b>Neville Resin</b> | Neville Co., Neville Island Post Office, Pittsburgh, Pa. |
| <b>Nevindane</b>     | Do.  |

## Varnish and Lacquer Resins

(Most of the products previously classified under the various chemical types are also used in synthetic finishes)

| Trade Name               | Composition                      | Manufacturer  |
|--------------------------|----------------------------------|---|
| <b>Abalyn</b>            | Methyl abietate                  | Hercules Powder Co., 999 Market St., Wilmington, Del. N. Y. office: 20 W. 40th St.                      |
| <b>Acryloid</b>          | Acrylic                          | Resinous Products & Chemical Co., Inc., 222 W. Washington Square, Philadelphia                          |
| <b>Acrysol</b>           | Do.                              | Do.   |
| <b>Aero Ester Gum</b>    | Rosin-glycerol                   | American Cyanamid Co., 30 Rockefeller Pl., New York, N. Y.  |
| <b>Alco</b>              | Phenolic                         | Do.   |
| <b>Amberlac</b>          | Alkyd                            | Resinous Products & Chemical Co., Inc., 222 W. Washington Square, Philadelphia                          |
| <b>Amberlite</b>         | Synthetic Resin                  | Do.   |
| <b>Amberol</b>           | Phenolic                         | Do.   |
| <b>Aquaplex</b>          | Alkyd                            | Do.   |
| <b>Aroclor</b>           | Chlorinated diphenyl             | Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo. N. Y. office: 30 Rockefeller Pl.                 |
| <b>Beckol</b>            | Alkyd                            | Beck, Koller & Co., Inc., 601 Woodward Hts., Detroit, Mich.   |
| <b>Beckonol</b>          | Do.                              | Do.   |
| <b>Beckopal</b>          | Phenolated copol                 | Do.   |
| <b>Beetle</b>            | Urea-formaldehyde                | Beetle Products Div., American Cyanamid Co., 30 Rockefeller Pl., New York, N. Y.                        |
| <b>Delux</b>             | Alkyd                            | E. I. du Pont de Nemours & Co., Inc., 11th & Orange Sts., Wilmington, Del. N. Y. office: 350 Fifth Ave. |
| <b>Duro</b>              | Phenolic                         | Paramet Chemical Corp., 1017 Forty-fourth Ave., Long Island City, N. Y.                                 |
| <b>Duxplex</b>           | Alkyd                            | Resinous Products & Chemical Co., 222 W. Washington Square, Philadelphia, Pa.                           |
| <b>Entrol</b>            | Alkyd                            | Paramet Chemical Corp., 1017 Forty-fourth Ave., Long Island City, N. Y.                                 |
| <b>G</b>                 | Glycerol-phthalic anhydride      | Makelot Corp., 262 Washington St., Boston, Mass.  |
| <b>Glyptal</b>           | Alkyd                            | General Electric Co., 1 River Rd., Schenectady, N. Y.   |
| <b>Hercosyn</b>          | Hydrogenated methyl abietate     | Hercules Powder Co., 999 Market St., Wilmington, Del. N. Y. office: 20 E. 40th St.                      |
| <b>Imperial Ester</b>    | Rosin-glycerol                   | J. D. Lewis, Inc., 68 Traverse St., Providence, R. I.   |
| <b>Kopol</b>             | Esterified copols                | Beck, Koller & Co., Inc., 601 Woodward Hts., Detroit, Mich.   |
| <b>Lentrol</b>           | Alkyd and phenolic               | J. D. Lewis, Inc., 68 Traverse St., Providence, R. I.   |
| <b>Paramet</b>           | Phenolic                         | Paramet Chemical Corp., 1017 Forty-fourth Ave., Long Island City, N. Y.                                 |
| <b>Paramet Ester Gum</b> | Rosin-glycerol                   | Do.   |
| <b>Paramol</b>           | Phenolic                         | Do.   |
| <b>Paraplex</b>          | Alkyd                            | Resinous Products & Chemical Co., 222 W. Washington Square, Philadelphia, Pa.                           |
| <b>Petrol</b>            | Terpinene maleic anhydride       | Hercules Powder Co., 999 Market St., Wilmington, Del. N. Y. office: 20 E. 40th St.                      |
| <b>Phenac</b>            | Phenolic                         | American Cyanamid Co., 30 Rockefeller Pl., New York, N. Y.  |
| <b>Rasone Ester</b>      | Rosin-glycerol                   | Robert Rauch, Inc., 480 Frelinghuysen Ave., Newark, N. J.   |
| <b>Rasone Resyl</b>      | Phenolic, etc.                   | Do.   |
| <b>Santallin</b>         | Alkyd                            | American Cyanamid Co., 30 Rockefeller Pl., New York, N. Y.  |
| <b>Santallin</b>         | Toluene sulfonamide formaldehyde | Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo. N. Y. office: 30 Rockefeller Pl.                 |
| <b>Santo Resin</b>       | Petroleum hydrocarbon            | Monsanto Petroleum Chemicals Inc., Dayton, Ohio   |
| <b>Synthe-Copal</b>      | Rosin-glycerol                   | Beck, Koller & Co., Inc., 601 Woodward Hts., Detroit, Mich.   |
| <b>Toplac</b>            | Alkyd                            | American Cyanamid Co., 30 Rockefeller Pl., New York, N. Y.  |

|                 |                   |  |
|-----------------|-------------------|--|
| <b>Uformite</b> | Urea-formaldehyde | Resinous Products & Chemical Co., 222 W. Washington Square, Philadelphia, Pa.      |
| <b>Vinsol</b>   | Modified rosin    | Hercules Powder Co., 999 Market St., Wilmington, Del. N. Y. office: 20 E. 40th St. |
| <b>Vinylold</b> | Vinyl resin       | Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York                         |

## Miscellaneous Plastics

|                           |  |   |
|---------------------------|--|---|
| <b>Acwalle</b>            | Pyroxylin                              | Celluloid Corp., 10 E. 40th St., New York   |
| <b>Aldenol</b>            | Phenolic denture material              | E. K. Medical Gas Laboratories, Bloomfield, N. J.   |
| <b>Amassay</b>            | Pyroxylin                              | Celluloid Corp., 10 E. 40th St., New York   |
| <b>Amarglo</b>            | Do.                                    | Do.   |
| <b>Amorith</b>            | Do.                                    | Do.   |
| <b>Andruson</b>           | Resin coated textiles                  | Andrew McLean Co., 8 E. 34th St., New York, N. Y.   |
| <b>Aquasol</b>            | Glycol borate                          | Glyco Products Co., Inc., 949 B'way, New York   |
| <b>Arcollite</b>          | Phenolic                               | Consolidated Molded Products Corp., 1935 Case St., Scranton, Pa. N. Y. office: 1776 B'way.                      |
| <b>Art-Y-Zan</b>          | Pyroxylin                              | Celluloid Corp., 10 E. 40th St., New York   |
| <b>Bestleware</b>         | Urea moldings                          | Beetle Products Div., American Cyanamid Co., 30 Rockefeller Pl., New York, N. Y.                                |
| <b>Benaloid</b>           | Uncured lignin sheets                  | Masonite Corp., Laurel, Miss.   |
| <b>Benalite</b>           | Cured lignin sheets                    | Do.   |
| <b>Bonnyware</b>          | Urea moldings                          | Reynolds Molded Plastics, Div., Reynolds Spring Co., 1305 Reynolds Bldg., Jackson, Mich. N. Y. office: 90 West. |
| <b>Cellanite</b>          | Phenolic laminated                     | Continental Diamond Fibre Co., Newark, Del. N. Y. office: 230 Park Ave.   |
| <b>Celoron</b>            | Phenolic gear stock                    | Do.   |
| <b>Cellophane</b>         | Regenerated cellulose wrapping         | E. I. du Pont de Nemours & Co., Inc., 350 Fifth Ave., New York  |
| <b>Charmour</b>           | Cellulose acetate                      | Celluloid Corp., 10 E. 40th St., New York   |
| <b>Ciba</b>               | Aniline resin                          | Ciba Co., Inc., 626 Greenwich St., New York, N. Y.  |
| <b>Clair de Lune</b>      | Cellulose acetate                      | Celluloid Corp., 10 E. 40th St., New York   |
| <b>Colasta</b>            | Phenolic, etc.                         | Specialty Insulation Mfg. Co., 55 Center Ave., Hoosick Falls, N. Y.   |
| <b>Celtroc</b>            | Phenolic product, exceptionally inert  | Colt's Patent Fire Arms Mfg. Co., 1935 Van Dyke Ave., Hartford, Conn. N. Y. office: 20 Vesey St.                |
| <b>Durium</b>             | Resorcinol-formaldehyde                | Durium Products Corp., 460 W. 34th St., New York, N. Y.   |
| <b>Fiberdant</b>          | Cellulose acetate denture              | Fiberloid Corp., Indian Orchard, Mass. N. Y. office: 60 E. 42nd St.   |
| <b>Fiberlac</b>           | Cellulose nitrate lacquer              | Do.   |
| <b>Gemloid</b>            | Pyroxylin                              | Gemloid Corp., 425 Fourth Ave., New York, N. Y.   |
| <b>Glycene</b>            | Alkyd denture                          | Bakelite Corp., 247 Park Ave., New York   |
| <b>Glycol Bori-Borate</b> | Water soluble resin                    | Glyco Products Co., Inc., 949 B'way, New York, N. Y.  |
| <b>H-Scala</b>            | Synthetic pearl essence (mercury salt) | Celluloid Corp., 10 E. 40th St., New York, N. Y.  |
| <b>Halowax</b>            | Chlorinated naphthalenes               | Halowax Corp., 247 Park Ave., New York  |
| <b>Harvel</b>             | Cashew nut derivative                  | Irvington Varnish & Insulator Co., Irvington  |
| <b>Haskelite</b>          | Plywood bonded with phenolic resin     | Haskelite Mfg. Co., 208 W. Washington St., Chicago, Ill.  |
| <b>Haves</b>              | Phenolic-asbestos                      | Haves Corp., E. Newark, Del.  |
| <b>Hamco-ware</b>         | Urea moldings                          | Bryant Electric Co., 1934 Weaver Ave., Bridgeport, Conn. N. Y. office: 100 E. 42nd St.                          |
| <b>Hercose C</b>          | Cellulose acetate butyrate             | Hercules Powder Co., 999 Market St., Wilmington, Del. N. Y. office: 20 E. 40th St.                              |
| <b>Hominit</b>            | Moulage (positive mass)                | Kern Co., 136 Liberty St., New York, N. Y.  |
| <b>Ivaleur</b>            | Pyroxylin                              | Celluloid Corp., 10 E. 40th St., New York   |

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| <b>Kodapak</b>              | Cellulose acetate                                   | Eastman Kodak Co., Rochester, N. Y.  |
| <b>Lactex</b>               | Coated fabrics                                      | L. E. Carpenter Inc., 444 Frelinghuysen Ave., Newark, N. J.  |
| <b>Lausite</b>              | Urea-formaldehyde, zinc chloride, resin for plywood | I. F. Laucks Inc., Maritime Bldg., Seattle, Wash.  |
| <b>Luxene</b>               | Phenolic denture                                    | Bakelite Corp., 247 Park Ave., New York  |
| <b>Maizite</b>              | Plastics from corn gluten                           | American Maize Products Co., 100 E. 42nd St., New York, N. Y.  |
| <b>Micabond</b>             | Phenolic bonded mica                                | Continental Diamond Fibre Co., Newark, Del. N. Y. office: 230 Park Ave.  |
| <b>Micanite</b>             | Mica  | Mica Insulator Co., 200 Varick St., New York   |
| <b>Micoid</b>               | Phenolic laminated                                  | Do.  |
| <b>Negocoli</b>             | Moulage (negative mass)                             | Kern Co., 136 Liberty St., New York, N. Y.   |
| <b>Nevillac</b>             | Phenol-indene coumarone                             | Neville Co., Neville Island Post Office, Pittsburgh, Pa.   |
| <b>Nevillite</b>            | Hydrocarbon   | Do.  |
| <b>Norbo</b>                | Phenolic resin                                      | Bakelite Corp., 247 Park Ave., New York  |
| <b>Plastico</b>             | Moulage (positive & negative)                       | California Art Supply Co., Inc., Palo Alto, Cal.   |
| <b>Plexigum</b>             | Acrylic resin for laminated glass                   | Eastern representative: Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.  |
| <b>Presdwood</b>            | Laminated lignin                                    | Röhm & Haas Co., Inc., 222 W. Washington Square, Philadelphia  |
| <b>Primal</b>               | Acrylic resin for leather finishes                  | Masonite Corp., Laurel, Miss.  |
| <b>Protecto</b>             | Cellulose acetate box toe material                  | Röhm & Haas Co., Inc., 222 W. Washington Square, Philadelphia  |
| <b>Prote-toid</b>           | Cellulose acetate wrapping material                 | Celluloid Corp., 10 E. 40th St., New York, N. Y.   |
| <b>Prystal</b>              | Cast phenolic (clear)                               | Do.  |
| <b>Resisto</b>              | Pyroxylin box toe material                          | Catalin Corp., 1 Park Ave., New York   |
| <b>Resovin</b>              | Vinyl denture                                       | Celluloid Corp., 10 E. 40th St., New York  |
| <b>Revolite</b>             | Cloth impregnated with phenolic resin               | S. S. White Dental Mfg. Co., 211 S. 12th St., Philadelphia, Pa.  |
| <b>Resilwood</b>            | Phenolic laminated wood                             | Zapon Div., Atlas Powder Co., Stamford, Conn.  |
| <b>RHonite</b>              | Urea resin  | I. F. Laucks Inc., Maritime Bldg., Seattle, Wash.  |
| <b>RHoplex</b>              | Acrylic resin for textile finishes                  | Röhm & Haas Co., Inc., 222 W. Washington Square, Philadelphia  |
| <b>Ronyx</b>                | Corn protein plastic                                | Do.  |
| <b>Safety Samson</b>        | Cellulose acetate film base                         | Resinox Corp., 230 Park Ave., New York   |
| <b>Samson</b>               | Pyroxylin film base                                 | Celluloid Corp., 10 E. 40th St., New York  |
| <b>Sundora</b>              | Cellulose acetate                                   | Do.  |
| <b>Sylphwrap</b>            | Regenerated cellulose wrapping                      | E. I. du Pont de Nemours & Co., Inc., Plastics Dept., 626 Schuyler Ave., Arlington, N. J. N. Y. office: 350 Fifth Ave. |
| <b>Tec</b>                  | Cellulose acetate                                   | Sylvania Industrial Corp., 122 E. 42nd St., New York, N. Y.  |
| <b>Tego</b>                 | Phenolic resin for plywood                          | Tennessee Eastman Corp., Kingsport, Tenn. N. Y. office: 171 Madison Ave.   |
| <b>Terylite</b>             | Vinyl resin sheeting                                | Resinous Products & Chemical Co., 222 W. Washington Square, Philadelphia, Pa.  |
| <b>Vinal</b>                | Vinyl acetal resin for safety glass                 | Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y.  |
| <b>Vinylite X</b>           | Do.   | Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York   |
| <b>Vinylseal</b>            | Vinyl resin sealing compound                        | Do.  |
| <b>Vispronal (Vistanex)</b> | Hydrocarbon resin                                   | Advance Solvents & Chemical Corp., 245 Fifth Ave., New York  |
| <b>Valcold</b>              | Phenolic laminated vulcanized fibre                 | Continental Diamond Fibre Co., Newark, Del. N. Y. office: 230 Park Ave.  |
| <b>Vydon</b>                | Vinyl denture                                       | Lee S. Smith & Son Mfg. Co., 7325 Pennsylvania Ave., Pittsburgh  |
| <b>Vynilene</b>             | Vinyl denture                                       | Coe Laboratories, 6033 S. Wentworth St., Chicago, Ill.   |